Concrete

Vol. 26 *Detroit, May, 1925* *No. 5*

"Insuring" the Quality of the Structure

ANY movement that is undertaken seriously to save the public from the costly cheapness of the jerry-builder is worth looking into. Since there has been frequent occasion to emphasize the slap-'em-up-quick methods of shoddy speculative building, particularly houses, often foisted on the unsuspecting public under financing arrangements which make home owning a real burden and practically an impossibility under the subsequent costly upkeep, it is good to know that one more large factor in the building industry—the dealer, through the National Builders' Supply Association has taken over the Master House Bureau idea and will be sponsor for "The Safeguard policy." This policy, devised to promote chiefly particular brands and kinds of "hard" material in construction will now be so re-written as to cover well-built buildings, under specifications which can be depended upon as to the quality of the materials and the character of the workmanship. The value of the "insurance policy" to be available through the dealer and to be sworn to by architect, builder and material man, is to give the owner *some* assurance at least that his is not a jerry-built job.

It is broadly an educational idea where the value is mostly psychological, to be supported by educational advertising to arouse the public interest in better buildings. The time seems to be ripe for the successful working out of such plans, because there are so many thousands of examples of houses built of which no guarantee could be written, unless it would be a guarantee that they would go to pieces in a minimum time. From the sale of the policies through the dealer association a fund will be created to prosecute offenders under the terms of the policy. While the man in the street is likely to be conversant with the internal mechanism of motor cars, he is usually grossly ignorant of the things that go to make quality in the house in which he lives. With understanding of quality will come a demand for it. In this the sponsors of the movement hope to reap their reward through the demand for better materials. If this demand for better materials and better workmanship comes—and it is sure to come eventually—it will automatically combat the evils of jerry-building as they have been seen in this country in the last few years in the wake of higher building costs.

No one will imagine the "safeguard policy" to be a cure-all for botchy building but in its serious promotion there is a wholesome realization of the need for better things. And it must not be forgotten that the best insurance is in employing the services of honest and responsible builders.

Scientific Aggregate for Quality Control

WHERE can the builder more appropriately look for assistance in applying our more recent scientific knowledge of quality control of concrete than to the producer of aggregates. While the large field job, or the factory working through thousands of yards of concrete may readily set up the machinery to get the mix it wants, the day of application of quality control can be hastened, insofar as standardized aggregates are concerned, when the producer of such aggregates recognizes the newer demands of scientific concreting in which not all gravel or stone, direct from the arbitrary screens and crushers, is *aggregate* in the newer and more exact conception of the term, in which the demands vary with the strengths specified and the nature of the structures or the masonry units in which the aggregates are to be used.

The Acme Products and Gravel Co., whatever the merits of its products, is doing a progressive and constructive piece of advertising in laying hold of recent technical knowledge as a means to get the merits of its gravel before, in this instance, the products manufacturers chiefly. The company circulates a Portland Cement Association pamphlet entitled *The Manufacture of Concrete Masonry Units.* This goes into the matter of correct mixtures and economical production by the use of the more recently developed technical knowledge which we have of quality control as it is possible in the products plant through the use of clean, coarse, well graded material of *known* sizes. Inside the cover of this pamphlet the Acme company puts a four-page insert telling its own story of the material which it has for sale for making better concrete, and of its own use of this product in making concrete building units at Cement City. This story of the company's manufacturing and sales idea is introduced with a quotation from an article published in the February issue of CONCRETE descriptive of the results obtained by W. B. Trost, Waterloo Concrete Corp., Waterloo, Iowa, in the manufacture of concrete staves for 100 silos a year. "By adding brains to the mix he (W. B. Trost) has increased his output of staves per sack of cement 25%; increased the strength of his product 100%; reduced the absorption 50%; and cut the breakage from 3% to 1%."

With the producer on his side, the products manufacturer and the contractor, even the big contractor, has one less factor to juggle with in getting the right mix.

Why cannot aggregate be bought by number, designating a definite size limitation and fineness modulus. Even the water problem is then made easier of solution.

Concrete and the Craftsman

THE hope and prospect of a twentieth century architecture in which concrete will be the basic material and in the final treatment of which we may yet hope for the reascendancy of real craftsmen, are expressed in a paper by Frederick R. Hiorns, before the Royal Institute of British Architects in March, as reported in *The Builder*, London. Mr. Hiorns said in part:

If the nineteenth century produced no distinctive expression of building, was it not because its problems were not frankly faced in an era of make-believe? Even the introduction of steel construction had, until recently, received little acknowledgment in the visible expression of buildings, which continued to show both form and ornament based on the materials and constructive methods of the pre-steel age. To mention one or two obvious examples of a newer and more truthful tendency, Adelaide House might be quoted. It did not disguise, as so many buildings did, the basic constructive motive. And there was the remarkable French church, on entirely distinctive present-day lines, recently built in reinforced concrete at Vincennes (MM. Droiz and Marrast, S. A. D. G.). It seemed to recognize not only constructive truth and the relation of form to function but also the corporate principle in building that admitted the work of painters, sculptors and others—as well as the part of the architect—in their execution and resultant expression. Along the more sincere lines of such a work as this they might one day develop a twentieth-century architecture as well as stimulate a new expression in craftsmanship distinctive of their age. Even as to the position of the art worker and operative workman in the spiritual expression of building they would perhaps not quarrel with William Morris's claim that in the modern world the craftsman was everywhere subordinate, if indeed he had not largely ceased to exist; and that that formed the reason why the ordinary man, robbed of his chance of creation, had become mediocre. It was the instinct to express themselves that provided them with capacity for interest and contentment in life. Had not many architects experienced the ready response of present-day workmen when encouraged to give a personal touch to their work? How to reconcile that with mass-production of houses—with modern contract methods—and with certain aspects of trade unionism was, perhaps, more than any of them could say. But they could still assert that the principle of personal interest in work was essential to the achievement of what was best in any art or industry. Through the unfortunate breaking, a hundred years ago, of a long-established craftsmanship tradition, methods had ceased to be intuitive. The sense of personal interest on the part of all who made and did things needed therefore to be re-established, together with a realization that art—the whole process of expression—was not a luxury, but a necessity in which even simple men might share.

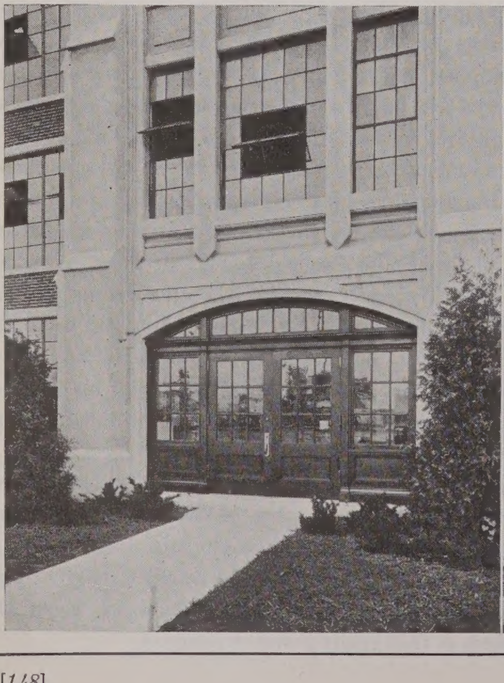
To whom should craftsmen more naturally turn for advice, encouragement and what might be called discriminating employment, than to architects, who, if they viewed correctly the art they practiced, should be able to value rightly and lead to the best use such talent of skill as mural painters, sculptors, and other workers in the crafts allied to architecture might display? Craftsmen everywhere should be able to look to architects as their natural protectors and, in the best and fraternal sense, their patrons, with the prospect of results from such cooperation distinctly to the advantage of the all-embracing art of architecture. For out of the general mass of mediocre work of today it was not difficult to find, in every craft, the work of living men comparable in its artistry and skill with the products of the great periods of the past, and they would be doing less than justice to contemporary work not confidently to assert that claim.

Brick—What Kind?

The National Vigilance Committee, New York City, which occupies the conning tower of the Advertising world, to maintain fairness and honesty has candidly acknowledged an error in its earlier statement in regard to "What is brick," as follows:

Referring to our bulletin of July 20, 1924, on "What is Brick," reactions obtained show that the word when used alone is not sufficiently definite in that it is understood by many persons to refer to more than one kind of solid building unit of an approximate size—2¼ x 3¾ x 8 in. After further investigation of the various materials and manufacturing methods, we recommend that, to avoid any confusion whatsoever and in the interest of clarity, all advertisers of brick, whether of clay, concrete, sand-lime, or other material, state specifically in their advertising, the material content of the product.

Finishing the Exteriors of Concrete Buildings



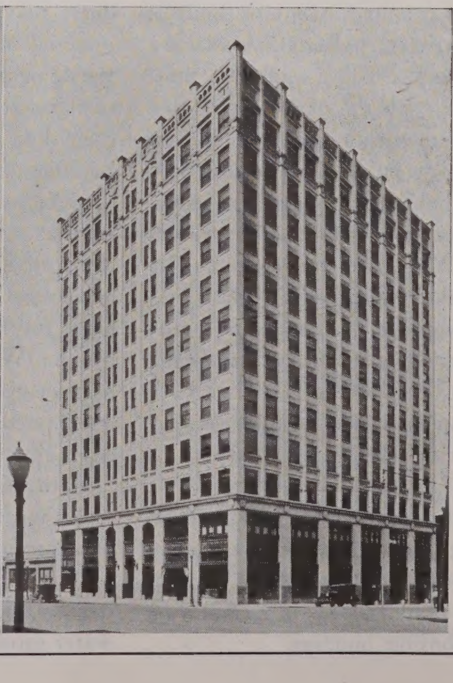


Fig. 1 — At Left — Surface obtained by use of cement grout coat

Fig. 2 — Right — An all - concrete office building in Atlanta. Good lines and surfaces make it harmonize with more ornate surroundings

Finish of Exterior Concrete Surfaces

By George E. Horr
CONTRACT ENGINEER, TURNER CONSTRUCTION CO.

Courtesy *Turner Constructor.*

The purpose of this article is to discuss the several methods of treating the exterior concrete surfaces of buildings in such a manner as to produce pleasing and durable surfaces.

Of recent years a great deal more attention has been given to the appearance of industrial buildings as owners have begun to appreciate that a reasonable expenditure is warranted in making the exteriors of such buildings pleasing to the public as an advertising feature, if for no other reason. Also more office buildings, such as the 101 Marietta St. Bldg., Atlanta, Ga., (Fig. 2) and high-class loft buildings are today being constructed with concrete exteriors in districts where a good exterior appearance is essential.

Many industrial buildings such as the Mint Products Co. building, Port Chester, N.Y., (Fig. 4), are designed with exposed concrete in combination with colored terra-cotta, colored tile inserts or face brick. In such buildings it is necessary to give the exposed concrete a treatment which will not be inconsistent with such a design.

In considering the finish to be given concrete surfaces, not only appearance must be considered but also the surface must be left in a condition to guard against disintegration from the action of the elements.

A good exterior appearance depends primarily on good architecture and general lines and as, due to the very nature of concrete, the forms are subject to a certain amount of distortion while being filled, very careful workmanship and supervision is required. Only sound, clean lumber of sufficient strength should be used for the forms and they must be carefully supported and braced in order to insure straight, true lines. The boards in the column forms should run vertically and in beams horizontally and should preferably be of uniform width so that the board marks many be continuous throughout. It is also obvious that care in concreting will eliminate a great deal of unnecessary expense in finishing, so the concrete should be carefully proportioned, mixed and placed in order to reduce to a minimum the need for patching or other corrective treatments. A reasonable amount of precaution to prevent the occurrence of defects is better and in the long run cheaper than the cure of such defects.

Thus assuming we have reasonably true and sound surfaces as the concrete comes from the forms it is necessary to decide on one of the following methods for finishing, depending upon the effect desired and the cost that is warranted.

1. (a) *Pointing.* (b) Correction of column and beam lines and dressing of fill lines, etc.
2. *Cement Grout* rubbed on the surface with a float.
3. *Surface rubbed* with coarse carborundum block and then refinished by a second rubbing with a finer carborundum block.
4. *Roughened Surfaces* exposing the aggreagte.
5. *Surface painted* with a proprietary coating.

The tools required for this work and referred to in the articles are shown in Fig. 7.

POINTING

Nails, wires and bolts, that may have been inadvertently built in should be removed. If it is not practical to remove them they should be cut off at least one inch back from the surface so as to provide a sufficient key for the pointing mortar and, what is still more important, to insure against moisture reaching any pieces of iron or steel and thus causing rust spots, spalling and subsequent disintegration. Defective places in the concrete should be carefully cut out so as to remove all loose pieces, laitance, or foreign particles, such as sawdust, until sound concrete is reached. Whenever possible the cavity should be undercut so as to form a key to hold the patch.

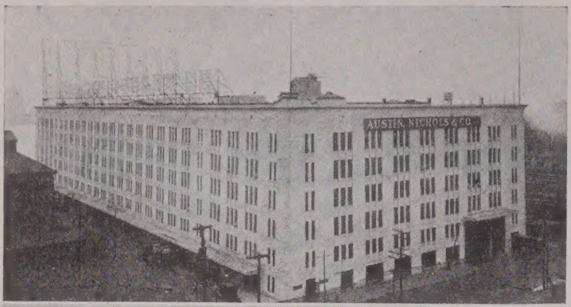
Bolt holes, always a potential source of leaks, should be carefully plugged with soft wood dowels or corks of 1/8-in. greater diameter than the hole. Our company has found corks are most effective and cheap for this purpose and have standardized on a 7-B wine cork for plugging 5/8-in. round bolt holes. If the corks are soaked in hot water they will become more pliable and thus insure a tighter fit. As an additional safeguard against leakage through bolt holes it is desirable to dip the plugs or corks in white lead before driving them in place. The plugs should be driven in until the head is at least 1 in. back from the surface.

If the entire surface is not to receive a further treatment which will bring it to an even color, it is desirable to use a fine sharp sand of light color for the pointing mortar, which should be mixed about one part of cement to two parts of sand by volume. A light colored sand should be used because a surface pointed with brown sand will usually show up darker than the surrounding concrete. The sand should be fine and sharp because if a coarse sand is used the texture of the patch as usually finished by float or brush will be rougher than the surrounding concrete. Before pointing is started it is well worth while to experiment with mixtures of different sands and cements, with possibly a percentage of white cement added, to obtain a mortar which when it dries will most closely resemble the surrounding concrete in color and texture.

The place to be patched and the sound concrete immediately around it should first be saturated with water. After the void is packed full of mortar the surface of the patch should be rubbed with a cork or wooden float so as to bring the patched surface to a plane with the adjacent concrete. Any mortar that may work out and lap over on the sound concrete should be rubbed off with a clean dry brush or piece of bagging.

The last operation should be to brush the patched surface parallel to the board marks. Do not leave the surface as finished by the usual circular motion of a float for this makes the patch more noticeable.

If it is necessary to make large patches of unusual depth and area the mortar should be applied in two or more coats. Each undercoat should be scored as in plaster work, but it is not necessary or desirable for each coat to become entirely dry before applying the next.



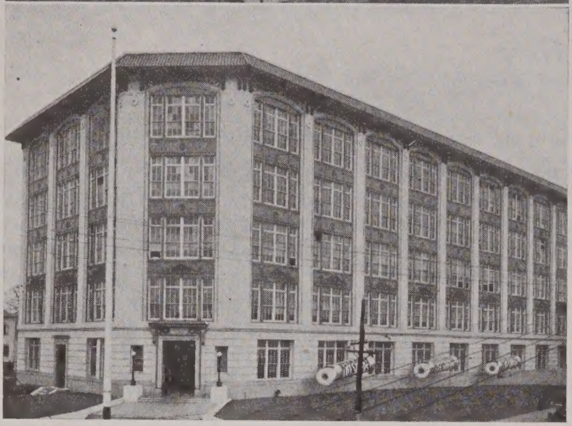


Fig. 3—Because of good lines and rugged character, irregularities of color are not objectionable

Fig. 4—Finished with light colored grout—curtain walls and mansard roof of green terra cotta

When a large patch is very prominent it may perhaps be made less conspicuous by again marking in the board marks to harmonize with the board marks in the adjacent unpointed surface.

Workmen doing the pointing should be instructed to watch for any reinforcing steel which is too near the surface and should see that possible future rusting is prevented by the methods discussed in the previous article on this subject. (See CONCRETE, Sept. 1924, p. 79—by courtesy *The Turner Constructor.*)

Patching should be avoided in hot sunshine or quick drying wind, unless it is feasible to protect the fresh mortar with wet burlap or canvas.

The work described above should always be required as a minimum treatment as it is necessary from the standpoint of durability, even if not for appearance.

CUTTING TO LINE

This section is supplementary to Section 1-a and prescribes additional corrective treatment, but not to the extent of eliminating board marks or bringing the surface to a uniform color.

Good judgment must be used in deciding how far the more expensive work of truing up bad lines and bringing surfaces to a plane should be carried, as a great deal of money may easily be spent without materially improving the general appearance.

Before the necessary patching has been done, as described in the previous section, the nail head marks, fins and other small projections should be removed. Beams which sag or bulge, and columns out of line should be cut to line. Fill lines should be dressed by thoroughly cleaning the joint and then applying mortar and finishing with a cork or wood float, and finally brushing out parallel to the board marks.

It has been our experience that the cheapest and quickest method for removing small projections is to pound them with a flat-headed hammer, causing them to crumble down to the general level of the surrounding surface. Projections of considerable size can be removed by chipping with an axe faced hammer or by cutting with a chisel.

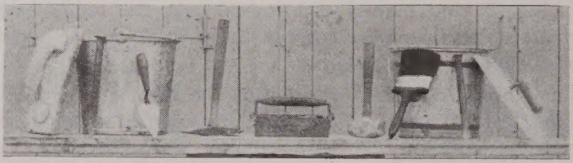
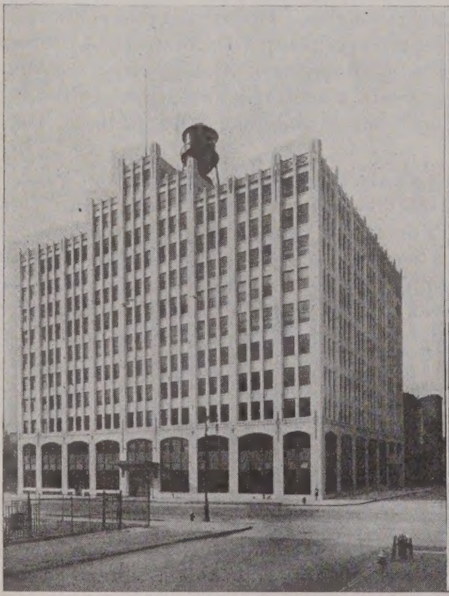


Fig. 7—Tools used in finishing concrete surfaces

When pointing and cleaning up around windows and miscellaneous iron, care must be taken to cut clean, sharp edges and not allow a film of mortar to lap over on the steel. For in time such a film will break away and leave a ragged edge and may in the case of windows cause a leak.

The work as described in the foregoing sections, 1-a and 1-b, is all that is required from the standpoint of durability. The surface will not be uniform in color and the patched spots may show up as darker spots on the surface, but after



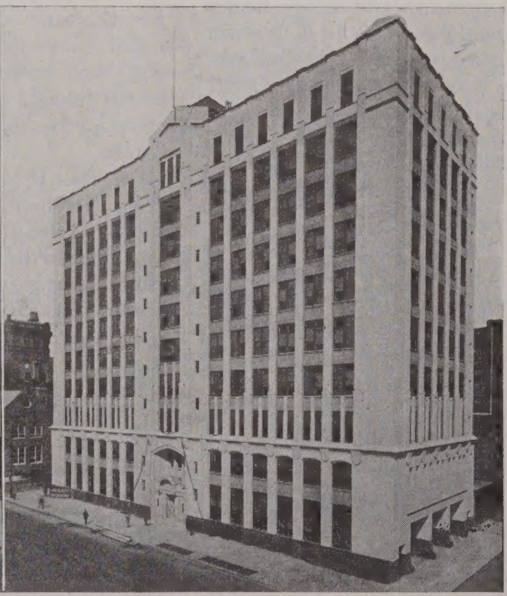


Fig. 5—Left—A proprietary paint was used on this concrete building

Fig. 6—Right—Finished with three shades of cement grout

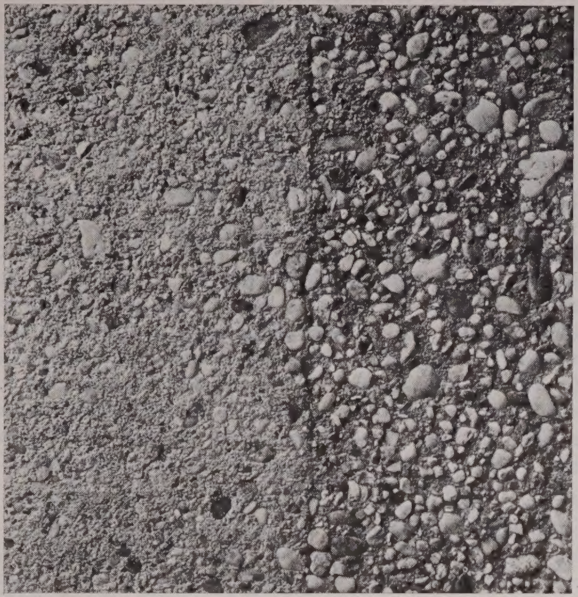


Fig. 8—Surfaces obtained by Johnson process

weathering for some time these irregularities in color will become less noticeable and the entire surface will become fairly uniform in color.

The irregularities in color and texture due to the patching will be much less noticeable in a large building of massive design than in a small building. The Austin Nichols Bldg., Brooklyn, N. Y., (Fig. 3) received no further treatment and yet, due to its massive simplicity, is one of the most impressive industrial buildings we have erected. If it were commercially possible to take sufficient care with the forms and concrete to turn out a perfect surface perhaps no exterior treatment, for a large building or other massive structure, would seem so suitable as the surface just as it comes from the forms with the board marks showing, but each board mark a true straight line. In this connection it is interesting to note that in designing the great new stadium for the University of Pittsburgh, which we are now building, the architect has used the board marks as a part of his architectural design. He shows the arrangement of the board marks on his elevations in the same way that the bonding for face brick would be worked out on a brick structure.

Although it is difficult to determine the exact cost of the work required by sections 1-a and 1-b, due to the varying amount of work on different buildings caused by the differences in architectural treatment, it may be assumed at about 3c a sq. ft. About one and one-half bags of cement will be used per thousand square feet of surface.

Cement Grout Rubbed on the Surface

Exterior surfaces can be colored from white or cream to the dark gray color of cement by applying wash coats of cement grout. This variation in color is obtained by varying the proportions of white or gray cement and light or dark colored sand, and, if desired, coloring pigments may be used. Before applying a grout coat all pointing, patching and other corrective work, as described in Section 1, should be completed.

A mixture of one part white cement and one part finely screened sharp yellow sand with 5% of hydrated lime (by volume of cement), will give a serviceable color just off the white, and will serve as an example of a typical dry mixture. The sand should be dry before screening, not only to facilitate the screening but also to avoid the possibility of moisture in the sand causing a set in the dry mix. Best results seem to be obtained with sand screened through a sieve having 18 meshes per lineal inch.

The cement, sand and lime in the desired proportions should be thoroughly mixed in the dry state, preparing enough material for a full day's work. The dry mixture should then be slowly added to a half-pail of water, stirring vigorously until the consistency is that of a stiff oil paint. Only enough of the wash should be prepared at any one time to last for one hour. The wash should be stirred before each application to the concrete surface, and before refilling the container all the old wash should be cleaned out and discarded.

The area to be coated must first be *thoroughly saturated* with water and then a heavy brush coat of the wash applied and thoroughly rubbed into the surface with a cork or wooden float, the surface meanwhile being sprinkled with a little additional water if necessary. The next step is to go over the surfaces with a clean, damp brush, brushing in the direction of the board marks, removing all excess material so the remaining coat will be as thin as will permit the surface to be entirely covered.

When coating adjacent areas the brush marks must be carefully blended to avoid a line between the two sections of work. If practical, the sequence of the work should be planned so that joinings occur at natural breaks in the surface. If this is impossible, then the joints between finish applied at different times should be made absolutely straight lines located where such a line, if it shows, will not be objectionable.

The coated areas must be sprinkled with water after the wash takes its initial set, for if it dries before the cement sets it will dust off. In warm or drying weather the finished surface should be sprinkled once a day for three days, and in cool, damp weather should be sprinkled at least once within twenty-four hours after application. The sprinkling must be gentle so as not to wash off the fresh coating. The simplest method we have been able to devise for sprinkling the exterior of a building is to connect a length of perforated iron pipe to a water hose. The pipe is then lowered from the roof and moved as required to wet the entire surface.

The importance of keeping the surface wet until the wash sets cannot be over-emphasized, for dusting or scaling will most certainly follow if this is not done.

The Fletcher Castoria Co. Bldg., New York City (Fig. 6), is an excellent example of a building finished by this method, and

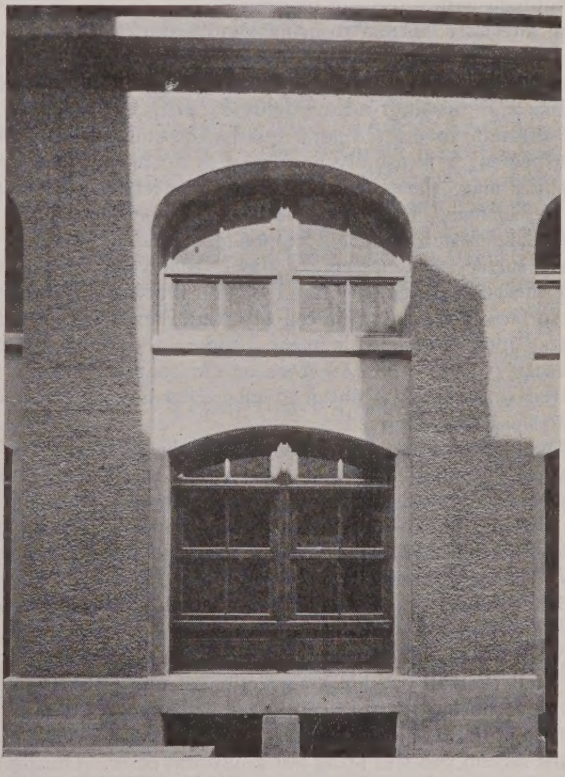


Fig. 9—Tooled surface

with the use of three shades of the grout. For the body of the building an almost white finish such as described above was used. The curtain walls were treated with a grout made with grey cement and the finish on the base course was colored with lamp black. Fig. 1 shows the main entrance of the Creighton Bldg., Lynn, Mass., which was finished by the above method.

A cement wash will cost about 6½c per sq. ft. and will require about one bag of cement per thousand square feet. Adding the cost of the work under sections 1-a and 1-b, the total cost of this method of surface treatment should be about 10c per sq. ft. and the total material one and one-half bags of grey cement and one bag of white cement per thousand square feet.

RUBBED FINISHES

The type of finish described in this section produces probably one of the most durable effects possible with a concrete surface. When properly done the finished surface resembles limestone in color and texture and will endure as long as the building.

To obtain the best results the forms on the faces of columns, beams and walls should be removed in twenty-four hours if possible and the soffits of beams should be removed within three or four days. The exact time depends on climatic conditions, but the first rub should be given while the concrete surfaces are still green, unless the arrangement of the work is such as to make it dangerous for the finishers to work so close under the erection of the forms for work above.

As soon as the forms are removed the surface should be straightened as to line and the larger fins, board marks, etc., removed by chipping and the voids filled with mortar as described in section 1.

The surface should then be soaked with water and rubbed with a No. 20 carborundum stone, until the irregularities are removed and the surface is ground to the desired degree of smoothness. The cement paste worked up should be removed by brushing or washing. If necessary, to facilitate the rubbing, instead of using only water, apply a thin grout of one part cement and one and one-half parts fine, sharp sand. Then, as soon as rubbing is completed, remove all the material possible by rubbing with a piece of bagging.

An alternate method to using a stone during the first rub calls for applying a cement mortar coat, composed of one part cement to one part finely screened sand, to the green surface and rubbing it thoroughly in with a cork float. If this alternate is selected, and equally fine finished result may be expected, it is usually necessary to do more preliminary chipping and other surface work in connection with truing up the surface. Using this method the operator should be warned against leaving any appreciable thickness of mortar on the surface, or craze cracks may later develop.

If the concrete cannot be given the first rub while green the surface should be saturated with water and a little cement mortar applied so as to help the grinding action. It may be necessary to use a No. 18 stone on old concrete. After the desired smoothness is obtained all excess mortar or cement paste should be removed.

The final rub should be given near the end of the work after the building has been constructed to full height and danger of straining from other work is past. Starting at the top of the structure, and working down, the surface should be thoroughly saturated with water and rubbed with a No. 24 carborundum stone until a smooth, even surface is obtained. Any paste that may work up should be removed with a clean, damp brush.

When using the method described in this section it is essential that all patching, correction of lines, etc., be done before or during the first rub. The irregularities of color or texture noticeable after the first rub need not be considered, as the second rub will bring out a uniform color. During the second rub nothing but the stone and plenty of water should be used. If a slightly lighter color is desired for the finished surface, a pint of hydrated lime may be added to each 14 qts. of water used during the final rub.

The cost of this process, including miscellaneous pointing, and first and second rub, is about 14c per sq. ft. and requires very little cement, or at the most not over one bag per thousand square feet.

ROUGHENED SURFACES

The effects that are possible by use of the various treatments of this kind are perhaps the most pleasing of any, but at the same time are the most costly and difficult to do. Not only must the direct cost of the tooling or scrubbing be considered, but also considerable indirect expense is involved because of the unusual care which must be taken with the form work, placing of concrete and location of fill lines where they will be least noticed. These treatments must be considered from an aesthetic viewpoint, as they do not add to the weather-resisting qualities of the surface, and in, fact decrease the protection given to the steel reinforcement.

As here used the term "roughened surfaces" includes all finishes where the surface of the concrete is roughened or removed to expose the aggregate. Wire or fibre brushes, stone dressing tools, and rotary cutters may be used for this purpose. The Sand Blast is sometimes use, but, after three trials by our company on as many different buildings, we have not been able to get satisfactory results by its use.

The success of the finished result depends primarily upon the uniformity obtained and therefore special attention is called to the importance of avoiding joints, fill lines, laitance and segregation of aggregate. Careful selection of the aggregate helps in obtaining the desired uniformity and if the aggregate be selected for color its exposure by scrubbing or tooling will introduce pleasing effects in color variation as well as texture.

Whan any of the rough surface treatments are used, great care must be given to the proper layout of construction-joints and fill lines and plans showing the treated areas should be on the job before any concrete is placed. The work should be planned to eliminate as many joints as possible, particularly horizontal fill lines, and if the latter are unavoidable they should be absolutely level and free from laitance. As this type of finish is usually carried out in panel effects, care should be taken to lay out exact lines and to cut clean and sharp at the edges. The borders of the panels and such other parts of the surface as are not to be roughened must receive the usual pointing as described in section 1 with one of the wash or rubbed finishes, so as to harmonize with the tooled areas.

The face forms for all surfaces which are to be tooled should be straight, smooth, evenly matched, watertight, and so built that they can be removed without prying against or jarring the concrete. The surface of the face forms should be coated with petroleum or other water-repellent to prevent adhesion of the concrete.

The concrete should be thoroughly mixed, wet enough to flush and be spaded against the face form and carefully tamped so as to obtain a uniform mixture at the face. The placing of concrete should be continuous throughout definite stages, so that the joints between different days' work are, if possible, concealed by the re-entrant angle at some projection.

SCRUBBED FINISHES

When a scrubbed finish is required, the forms should be removed, at a time to be determined by experiment, while the concrete is green (usually not over 48 hours after placing concrete) and the concrete scrubbed with a wire or stiff fibre brush until the surface film is removed and the aggregate exposed to a uniform degree. Then the surface should be rinsed off with water and kept moist for several days.

If any pointing is required, the defective spots shall be patched immediately after the scrubbing. After the patches have hardened (within 6 to 24 hours) they should be scrubbed to the same texture as the general surface and rinsed clean and kept moist for several days.

When for any reason the forms are not removed before the concrete has become too hard for scrubbing, the hard portion may be tool-dressed to a texture matching as nearly as possible the scrubbed surface. After such treatment the surface should be washed with a 1 to 10 solution of muriatic acid and then thoroughly rinsed with water to remove all traces of acid.

Before deciding on the use of a scrubbed surface the effect of the use of such a treatment on the general construction costs should be carefully considered. To scrub the surface of a one-story wall is a simple matter, but when building a large multi-story building the forms from one story are immediately raised into place for the next story, which complicates the situation, as it is dangerous to put men at work on the scrubbing without overhead protection, and it is difficult and costly to arrange this so close under the forms. The supports for the forms above may overlap a part of the area to be scrubbed, so the work must be slowed down or the lapped sections tooled, at a later date, instead of scrubbed, and the difference in texture is almost sure to be noticeable.

There is also liable to be some dripping from the work above and if this occurs it may be necessary, after the completion of the work, to clean the scrubbed surfaces with muriatic acid in order to remove such stains.

Recently Nathan C. Johnson devised a very ingenious method which makes the scrubbing of concrete surfaces easier. Before the concrete is placed he paints the surface of the form that is to come in contact with the concrete to be scrubbed, with a chemical solution[1] which will soften the concrete surface to a desired depth depending on the strength of the solution used. The solution is soluble in lime water but insoluble in plain water. Therefore the chemical reaction only takes place after the concrete containing lime water is placed against the treated form.

The chemical action involved takes place within a few hours so that forms may be removed as usual. Upon the removal of the forms from the treated areas the concrete surface will be so softened that it can be readily brushed away like damp sand with wire or stiff fibre brushes, leaving aggregate exposed. As soon as the forms are removed and the treated area is exposed to the air, the surface begins to harden again so the brushing should be done within a few hours after removing the forms. This hardening action does not take place so long as the forms are left in place.

Fig. 8 shows an experimental concrete panel that has been treated with this process to obtain a scrubbed surface. The left of the panel was treated with a weak solution and the right part with a stronger solution.

While we have not used this method on a complete building we experimented with it on one of the curtain walls when we built our own shop. The method is certainly very novel and merits the attention of those who wish to obtain a scrubbed finish.

TOOLED SURFACES

Surfaces to be tooled should be at least two weeks old before treatment. The work may be done by mechanically operated tools, or by hand. In general the work on any one panel or area should be done by the same operator so as to avoid differences in texture. After the coarse aggregate is exposed to a uniform degree the roughened surface should be brushed with a fibre brush or washed with a hose stream to remove loose particles and dust.

If any pointing or filling of bolt holes is required it should be done after the tooling. The patching should be done by first pointing the spot with mortar and then embedding selected pieces of large aggregate in the mortar bed so as to match the surrounding tooled area. After the patches have thoroughly hardened they should be carefully dressed. The Rogers & Pyatt Bldg. (Fig. 9), is an excellent example of a tooled surface.

PPOPRIETARY COATINGS

There are several paints and coatings on the market which have been widely used and have given satisfaction, but no one should use a coating on an exterior concrete surface without first knowing the particular paint in question has been in general use for a number of years and has stood the test of time on concrete surfaces. It is desirable to select a painting contractor to apply the material who has a thorough knowledge of the particular paint from previous experience.

It should be noted that difficulty may be experienced in getting proprietary paints to adhere permanently to smooth concrete surfaces and especially troweled surfaces such as window sills.

It has been noted that proprietary paints, when applied in two coats, have at times not proved satisfactory, as there seems to be just enough pull or tension in two coats to cause blisters. In this connection, the priming coat of zinc sulfate which is recommended by some manufacturers as a neutralizer for free lime that may be present is not considered as a coat of paint.

If concrete surfaces are allowed to weather several months before applying oil paints the carbonic acid gas in the air will tend to unite with the free alkali in the cement, forming a neutral carbonite of lime, thus minimizing the action of the free lime in the concrete on the paint.

Some coatings contain a heavy mineral wax in solution in light asphaltic oils, and our experience has shown this type of preparation generally satisfactory both as to coloring and also as a waterproofing coat. After application the oil evaporates and leaves the wax deposited on the surface.

The exterior concrete surfaces of The American News Co., Inc., Bldg., New York City, were treated with this type of paint. (Fig. 9.)

Systems of Floor Construction

Among the most economical systems of floor construction, for light loads in hotels, apartment houses and similar buildings where a flat plastered ceiling is required, are tile and concrete joist construction. One difficulty encountered is the possible discoloration of plaster at the joists where plaster is applied directly. Some types of rib construction are also recommended for hotels, using metal forms spanning joists about 3 ft. apart. Two-way joists and panel construction has also proved economical, all arrangements being governed by the building code requirements for the locality.

Repairing Floors

Certain quite well established rules should be carried out in the repair of concrete floors. The following directions will give good results, and the question of the occupancy of the building is not important:

1. Clean the surface to be patched.
2. Roughen it.
3. Thoroughly soak the surface but leave no film of water.
4. Select for patching material aggregate the same as the original floor and mix the same proportions as originally used.
5. Apply with force as with a cement gun, then do not disturb until the patch has hardened.
6. Finish with the least possible trowelling and keep wet as long as possible.

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[1] Contex—

High Points of the New Joint Committee Report on Concrete

By Norman M. Stineman

STRUCTURAL ENGINEER, PORTLAND CEMENT ASSOCIATION, CHICAGO

Presented before the Eleventh Annual Meeting of the Building Officials Conference, April 21-24, 1925, at Madison, Wis.

The following paper by Norman N. Stineman, structural engineer, Portland Cement Association gives briefly the history of the Joint Committee reports and discusses a number of points wherein the new report differs from former reports.

Field control of concrete has been given a definite impetus by the report. This paper points out that the old nominal mixtures such as 1:2:4, 1:1½:3, etc., must go by the board, various field operations having proved that the production of quality concrete under actual construction conditions is beyond the experimental stage.

Certain phases of design practice are mentioned as high points of the new report, among which are changes to encourage the use of hooped columns having both longitudinal steel and closely spaced spiral reinforcement.

Further discussion of the points covered in the new report is invited.—*The Editors.*

The new Joint Committee report on concrete, dated August 14, 1924, has been published under the full title of "Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete."

This report was prepared by affiliated committees of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association, the American Concrete Institute and the Portland Cement Association. This is the same group of national organizations that sponsored the old Joint Committee Report known as the "Final Report of the Joint Committee on Concrete and Reinforced Concrete," dated July 1, 1916. These two publications are more commonly referred to as the old Joint Committee Report and the new Joint Committee Report.

HISTORY OF JOINT COMMITTEE REPORT

Both reports are the result of years of labor of 25 or 30 engineers of national reputation. Their work was first issued in the form of a preliminary report in 1908. From that time forward the successive Joint Committee reports have been quite generally accepted as the best authority on reinforced concrete design and construction. A revised report was issued in 1912, and the so-called Final Report in 1916. The members of that committee realized that they had by no means given out the last word in the design and construction of reinforced concrete. The committee members felt, however, that it was time for them to bring their work to a close. They expressed the hope that when further investigation and experience required it, some new body of men could take up the work of revision.

The Final Report of the old Joint Committee was not long in existence before new developments in the art of making concrete demanded attention. This was true in particular with respect to knowledge obtained on the influence of proper proportioning, on the harmful effect of excessive mixing water in concrete, on the importance of proper grading of aggregates, on the injurious effect of organic impurities in sand, on the value of thorough mixing, on the maintenance of favorable conditions for curing, on precautions necessary in concrete work during cold weather, and on measures required to prevent damage by alkali and sea-water. Other developments indicated that maximum shear values might be higher than had been supposed.

It was in June 1917, almost exactly a year after the adoption of the Final Report of the old Joint Committee, that the American Society for Testing Materials took the initiative in bringing about the appointment of a new Joint Committee to consider these further developments. War and post-war conditions prevented immediate action, so that it was not until February, 1920 that the new Joint Committee was finally organized, with a membership of 23 engineers, several of whom served on the previous committee.

The New Joint Committee issued a progress report under date of June 4, 1921, and a completed report dated August 14, 1924.

In its purpose the new report differs somewhat from the old Joint Committee Report of 1916. The old report specifically states that it is not a specification but may be used as a basis for a specification. The new report of 1924 is admittedly a specification intended to cover the general conditions affecting the design and use of concrete and reinforced concrete.

The new specification is not in building code form. It could not be incorporated bodily in a building code as a separate chapter on concrete and reinforced concrete. Its *recommendations* could be incorporated, but not its actual text. It will be of interest to building officials to know that a committee of the American Concrete Institute, some of whose members were members also of the Joint Committee, is now preparing a proposed building regulation covering concrete and reinforced concrete which will be based on the new Joint Committee Report, but will be written in building code language. When completed, it can be incorporated as a separate chapter in a general city building code. The first progress report of this Committee will appear in the *Proceedings* of the American Concrete Institute to be issued in June, 1925. It will be of great assistance to progressive building officials who like to keep their codes in line with engineering practice, but lack the necessary time to make a thorough analysis of the new Joint Committee Report.

WORKING STRESSES

In the new Joint Committee Report, as in the old, allowable working stresses in concrete are directly proportional to the crushing strength of the material at the age of 28 days. In general, the working stresses are somewhat higher than in the old report of 1916. This change is fully justified in view of the definite advances made in the control of the quality of concrete in the field. This I will discuss later.

The allowable direct compression in concrete in piers and pedestals whose length is not more than three times the least dimension is 25% of the crushing strength at the age of 28 days.

The allowable direct compression on the entire net area of concrete in columns reinforced with longitudinal bars and separate lateral ties is placed at a maximum of 20% of the crushing strength at 28 days. Allowable compression on the concrete in the circular core of a spirally reinforced column is a variable quantity depending on the ultimate crushing strength of the concrete at the age of 28 days, as before, but depending also on the percentage of longitudinal reinforcement, and on the percentage of spiral steel. A column having an unsupported length of more than 40 times the least radius of gyration must have the permissible stresses reduced in accordance with a formula given in Section 170.

The permissible extreme fibre stress in concrete in members under bending stress is placed at 40% of the crushing strength at the age of 28 days in ordinary cases, and 45% immediately adjacent to the supports of continuous beams.

If some of these allowable stresses seem to be high, your attention is invited to the fact that, in the first place, all these percentages are based on the strength of the concrete at the age of 28 days. The strength will of course increase quite rapidly for several months longer. Then, as regards the allowable stress in bending, the maximum occurs only at the extreme edge of the member. It decreases rapidly to zero at the neutral axis. Concrete of a given strength will show an extreme fibre strength in flexure of about 1.6 times the strength under direct compression. In other words, if a sample of concrete tests 2000 lb. per sq. in. in direct compression, the same material placed in a reinforced concrete beam could be expected to have an extreme fibre strength of about 3200 lb. per sq. in. Consideration of this fact, in conjunction with the rapid increase in strength for several months beyond the 28-day period, should convince anyone that the working stresses recommended in the Joint Committee Report are sufficiently conservative.

The maximum shear in beams, under the most favorable conditions, where the longitudinal steel at both top and bottom, as well as the web steel, is anchored mechanically or by means of hooks, may be 12% of the ultimate crushing strength of the concrete, as against 6% in the old Joint Committee Report. This does not mean that the shear reinforcement will be stressed to twice the amount permitted by the old report. It does mean that the total end shear may be double the amount sanctioned by the old report, although it naturally follows that about double the amount of shear reinforcement will be required in the extreme case.

Investigations and tests conducted by the U. S. Bureau of Standards were largely responsible for the revision of previous practice pertaining to shear.

As to steel reinforcement, the new Joint Committee Report sanctions the use of both billet-steel and rail-steel bars, and of cold-drawn steel wire. Billet-steel bars of structural grade and light structural steel shapes used as concrete reinforcement are allowed 16,000 lb. per sq. in. Billet-steel bars of the intermediate and hard grades, rail-steel bars and cold drawn steel wire are allowed 18,000 lb. per sq. in. Provision is made also for the consideration of stress in both concrete and steel in composite columns of reinforced concrete and structural steel. The same is true of columns of reinforced concrete with cast iron cores.

Field Control of Concrete

The control of the quality of concrete in the field has been given a definite impetus by the Joint Committee Report. The Committee itself sponsored a series of field tests carried out under the auspices of the Joint Committee of Contractors, on which the Associated General Contractors of America were represented, with the object of determining the practicability of maintaining control of the quality of concrete in the field under actual construction conditions. These field tests fully justified the Joint Committee recommendations.

The engineering and construction departments of certain railways have likewise taken the initiative in developing field practice for the control of the quality of concrete on actual construction work. Notable among them are the Big Four, the Central R. R. of New Jersey, the Pennsylvania Lines, both East and West, the New York Central, the Canadian National, the Northern Pacific, the Santa Fe and the Louisville & Nashville. They have proved to their own satisfaction that the production of quality concrete under actual construction conditions is beyond the experimental stage. It can now be said to be an accomplished fact.

This means, of course, that the old nominal mixtures of 1:2:4, 1:1½:3, and so on, must go by the board. They must give way to 1:6 and 1:4½, so as to permit the proper ratio between fine and coarse aggregates, whatever ratio may be necessary to produce the densest mixture for the materials in question. This means also that it is possible to predetermine the strength of concrete after a study of the materials to be used. The method followed in making this study is so simple that it can easily be carried out on the work in advance of construction and checked up as the construction proceeds.

Aggregates

The aggregates permitted for use are no longer confined to sand, gravel and stone. Whereas the old Joint Committee Report defines fine aggregate as sand or the screenings of gravel or crushed stone, the new report defines it as "sand or other approved inert materials." The old report defines coarse aggregate as gravel or crushed stone. The use of blast furnace slag actually is frowned upon. The new Joint Committee Report defines coarse aggregate as crushed stone, gravel or other approved inert materials with similar characteristics, or combinations thereof, having clean, hard, strong, durable, uncoated particles free from injurious amounts of soft, friable, elongated or laminated pieces, alkali, organic or other harmful matter. Consequently with regard to both fine and coarse aggregates, the new report sanctions the use of any material that has been found suitable, whether such materials are crushed stone, gravel, blast furnace slag, steam-boiler cinders chats, crushed brick-bats, or any other suitable material locally available.

Mixing

The new Joint Committee Report recommends definite measurements of fine and coarse aggregate and definite control of the quantity of mixing water to be used in each batch, so that the concrete will not only be of high quality, but of uniform quality as well. The minimum time for mixing is placed at one minute. The quantity of water used must be the minimum necessary to produce concrete of a workable consistency.

The consistency must be checked from time to time, either by the slump test or by some other known means.

Batch mixers must be used and must be equipped with charging hoppers, water storage and a water-measuring device controlled from a case which can be kept locked and so constructed that the water can be discharged only while the mixer is being charged. The mixer must also be equipped with an attachment for automatically locking the discharge lever until the batch has been mixed the required length of time after all materials are in.

Hand-mixing is of course authorized in special cases where the quantity of concrete is small or where the strength is of comparatively little importance.

Placing

The chuting of concrete is not entirely condemned, but the slope of the chute must be sufficiently steep so that the concrete will move along the chute without separation of the ingredients. The trouble with most chuting systems is that the slope is too flat. Such a system of distribution requires an extremely wet mixture of concrete to keep up the flow, with a consequent reduction in strength.

PROTECTION AGAINST HEAT AND COLD

Very definite recommendations are made in regard to protection against premature drying out in how weather, or against freezing in cold weather. During hot weather exposed surfaces shall be protected for a period of at least 7 days after the concrete is deposited. In cold weather concrete shall have a temperature at the point of deposit of not less than 40° F. nor more than 120°. Provision must be made for maintaining the concrete at a temperature of at least 50° F. for not less than 72 hours after it has been deposited. The reason for this minimum temperature of 50° arises from the fact that concrete sets very slowly when the temperature is less than 40° F. At 50° the setting process is quite normal. The minimum temperature has therefore been placed at 50° in order to keep it at a point where the hardening process will make normal progress.

Salt, chemicals or other foreign materials, when added to concrete, shall under no circumstances be considered as a substitute for protection against freezing. The danger in the use of salts, advertised commercially as non-freezing solutions, lies in the tendency of a careless construction foreman to consider tham as substitutes for protection against freezing. He is likely to take for granted that they will answer the purpose and that nothing more need be done. He overlooks the fact that concrete sets very slowly when the temperature is as low as 40° F. and not at all when it reaches the freezing point. Even though a chemical product may prevent actual freezing down to a temperature of 20 or 25°, the concrete will not harden at such temperatures.

DESIGN

Certain phases of design practice are worth mentioning here. For the purpose of design, the span length of a freely supported beam or slab shall be the distance between centers of supports, but need not exceed the clear span plus the depth of the beam or slab. In continuous or restrained beams or slabs the span length shall be the clear distance between faces of supports, with the further provision that a certain allowance will be made for brackets.

The permissible width of flange in a T-beam is increased to 8 times the depth of the slab on either side of the web, whereas in the old Joint Committee Report the limit was 6 times the depth of the slab. In other respects the two reports are in agreement on T-beams.

In the old report of 1916, the quantity of longitudinal reinforcement in spirally reinforced concrete columns was limited to a minimum of 1%, and a maximum of 4%, while the quantity of spiral steel was limited to not less than 1%. In the new report the longitudinal steel in spirally reinforced columns is limited to a minimum of 1% and a maximum of 6%, while the spiral reinforcement shall be not less than one-fourth of the volume of the longitudinal steel. These changes encourage the use of hooped columns having both longitudinal steel and closely spaced spiral reinforcement.

In the design of reinforced concrete columns as well as in composite columns of reinforced concrete and structural steel or cast-iron, consideration is given to the ratio between the unsupported length and the radius of gyration, instead of the least side or diameter, as in the old 1916 report. Provision is made for reduced unit stresses in slender columns, where the ratio of length to least radius of gyration exceeds 40. This is a new departure, inasmuch as the old Joint Committee Report and many building codes place an arbitrary limit on the length of a column at 15 times the least side or diameter. Other codes place the limit at ten. There is no reason why a reinforced concrete column or strut cannot be more slender than indicated by either of these limitations, provided the unit stresses are reduced proportionately. The new Joint Committee Report supplies a formula for computing this reduced stress. This might be of considerable importance in the design of a reinforced concrete trestle, water tower support or some other structure of a similar nature.

USE OF THE JOINT COMMITTEE REPORT IN BUILDING CODES

How may the new Joint Committee Report be utilized in that part of a building code relating to the design and construction of reinforced concrete structures? This question can be answered in several ways. The first and most tedious plan is to revise or rewrite the present regulations governing plain and reinforced concrete so as to make them conform in all important respects to the recommendations in the report. The second plan is to wait for the completion of the report of the American Concrete Institute Committee now engaged in writing building code regulations on the basis of the new Joint Committee Report, and then to incorporate that report in the general building code or printing it as a special ordinance. The third and simplest plan is to adopt the recommendations of the new Joint Committee Report by reference only. This plan involves the elimination of all existing parts of the code that pertain to reinforced concrete design and construction, and the inclusion, in their place of a paragraph such as the following:

> Features of the design and construction of reinforced concrete structures not covered by this section shall be governed by the rules and principles of standard practice, as published in the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete, dated August 14, 1924.

A footnote might state that copies of the Joint Committee Report can be obtained from the Secretary of the Joint Committee, 1315 Spruce Street, Philadelphia.

The actual wording of this proposed paragraph is chosen in view of the probability that it might be desirable to print a few fundamental requirements, such as a table of unit stresses. Other matters such as the minimum thickness for reinforced concrete walls, enclosures, and partitions, for which no provision is made in the Joint Committee Report, would have to be provided for. However, such special requirements could be placed in sections dealing specifically with thickness of walls and partitions.

In view of the very general acceptance of the Joint Committee as an authority, and the fact that this acceptance dates as far back as 1908, much trouble and expense could be saved in the preparation and printing of a building code if the third method of procedure were followed; that is, if the new Joint Committee Report or its American Concrete Institute counterpart were adopted by reference only.

Apprenticeship training in the construction industry may be brought to the attention of superintendents and foremen on the job by putting statistics before them as to the actual conditions which show that a supply of skilled mechanics is falling off.

Possible savings and economies resulting from the use of bulk cement depend upon the governing conditions, such as the length of haul to which the cement is subject, whehter or not air power is available and the size of the job. During long hauls bulk cement gets packed, but on a large job, the contractor can afford to put in air equipment and handle the bulk cement at a lower labor cost. It has been estimated on some jobs that the saving in labor and mechanical handling in the case of bulk cement amounts to 15 to 25%. An estimated saving of 5% in handling charges is made as compared with the baling and shipping of cement sacks back to the mills. Less damage due to moisture results where cement is shipped in bulk.

The Fundamental Cause of the Disintegration of Concrete

By Alfred H. White

Professor of Chemical Engineering, University of Michigan

Presented at the Eleventh Annual Conference on Highway Engineering at the University of Michigan, Ann Arbor, on February 17, 1925.

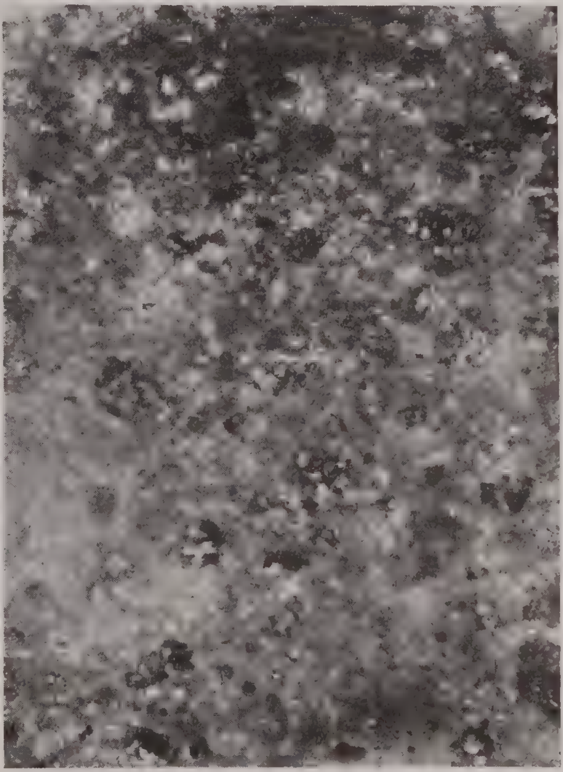

Fig. 1—Photomicrograph of thin section of briquet of neat cement stored 3 months in water and then in air

(The dark mottled patches are pieces of unchanged cement clinker which are imbedded in a dense white mass of decomposition products)

There are many, many structures in which portland cement is giving wonderful service, but nearly every one who keeps his eyes open is familiar with instances of the disintegration of concrete. The troubles may sometimes be due to inferior materials or poor workmanship but they may more frequently be laid to the user's ignorance of the fundamental properties of portland cement. It has many valuable properties and is one of our most important structural materials but it has latent possibilities of harm which no other major building material possesses. Its faults are, so far as we know, necessarily inherent in the material. The only safety lies in recognizing the weaknesses of portland cement and using it under proper conditions. It is proposed to present in this article some of the properties inherent in portland cement which are not generally recognized by engineers. The conclusions are based partly on observation of existing structures but also on studies made in the writer's laboratory during the last 25 years on many samples of cement obtained from commercial sources as well as those made in the laboratory.

The one property of portland cement which is of the greatest importance to the user is permanence. Our best index of permanence is constancy of volume and the conclusions drawn here are based largely on studies of changes in volume. There are over 500 expansion bars in the writer's laboratory with known histories, many of them extending over 20 years. Some of them illustrate the behavior of abnormal cements but most of them represent cements which have passed the standard specifications.

There will be no discussion of abnormalities in the present article. The discussion will deal entirely with the behavior of standard cements properly mixed with good water and kept, unless otherwise stated, in a laboratory of fairly constant temperature either immersed in distilled water or lying in air of room temperature. The results of observations in recent years confirm the conclusions announced by the author in earlier papers.[1]

The Hardening of Portland Cement

Portland cement is a chemical product, and all the processes connected with its setting and hardening are chemical. The causes of its misbehavior when improperly used are largely chemical. The processes connected with hardening are complicated and there is no clear agreement on the details. However, the broad outlines are clear and may be presented without chemical formulae.

Portland cement is a complex semi-fused mixture whose chief constituents are known to be silicates and aluminates of lime. There is some doubt about the exact form of combination of the elements and there is more doubt about the details of the processes which are involved when cement reacts with water. The old ideas of definite chemical combination are still firm in the minds of most engineers and many chemists, and the most prevalent conception of the mechanism of hardening is probably that portland cement reacts with water to form definite crystalline compounds which interlock and impart strength to the product. We know this is at least a half truth for the microscope shows the formation of crystals in the initial steps of the hardening process. The microscope also shows, however, the formation

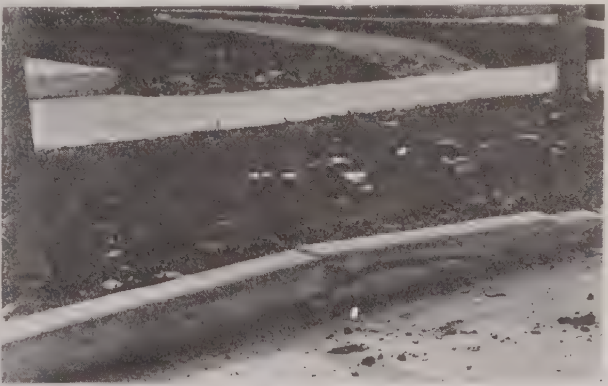

Fig. 2—Upheaval of concrete curb due to expansion

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[1] *Proc. Am. Soc. Test. Mat.* 11, 531 (1911) and 14, 204, (1914). *Proc. Int. Eng Congress*, San Francisco, 1915, vol. *Materials of Engineering Construction*, p. 242.

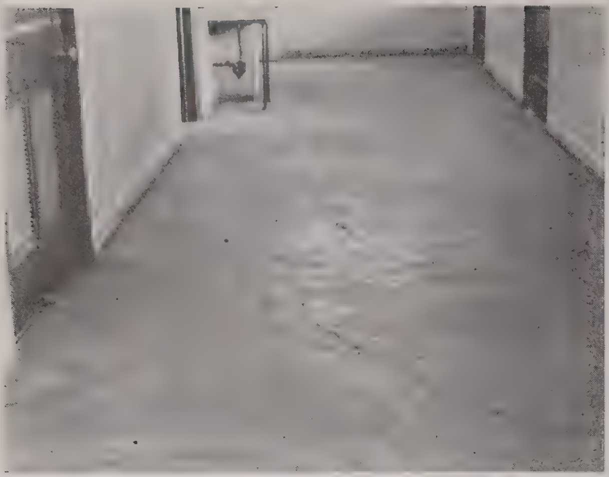

Fig. 3—Cracked cement floor due to contraction

of cloudy materials which fill the field so that further changes in the hardening process are obscured. If an observer at a microscope could have ideal conditions and follow the behavior of cement from the time of its initial contact with water, he would observe a rather voluminous white coat forming on each grain of cement. Some crystals would form and reach out to join or interlock with other crystals. Most of the products would, however, be pasty, or as the chemist says, colloidal, rather than crystalline. After a few hours the paste would have stiffened sufficiently to cause the cement to set. This paste or colloid would continue to get stiffer as the water ate deeper into each cement grain, forcing the decomposition products to pack more closely together. The action should logically continue until one of two things happens: either the cement becomes all decomposed by the water, or the reaction products become packed so tightly that no more water can force its way to the unchanged centers of the cement grains. If the cement becomes dry before either of these results happen, the process remains incomplete.

Some investigators have tried to study the hardening process of portland cement by observing the behavior of a small amount of cement suspended in a large amount of water. This condition is exactly the reverse of that which obtains in practice and does not lead to results which can be interpreted in the light of actual conditions. In any ordinary concrete it is the cement which is in excess and not the water. It is rare to have sufficient water present to combine with all the cement. Yet it is somewhat rash to say this, for there arises at once the query, how much water is actually combined with the cement in any given sample of concrete? The only truthful reply we can give to this is that we do not know and cannot find out. This seems like a surprising admission in this day and age, but it arises from our fundamental ignorance of what constitutes chemical combination. Where does moisture stop and chemically combined water commence? We cannot answer this question. One form merges into the other. In the light of our present knowledge it is probably safer to consider all water which is not present as actual drops of liquid as being in some form of combination and exerting an influence on the properties of the concrete.

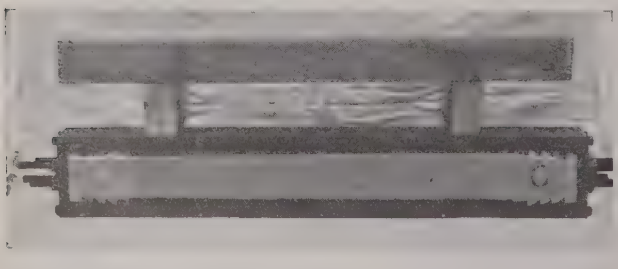

Fig. 4—Showing shrinkage crack in bar with restrained ends, and absence of cracks in free bar

This action of water on the grains of cement and the cessation of the reaction because of packing of the products is illustrated in Fig. 1 which is a photomicrograph of a thin section of a briquet of neat cement, which had lain in water for three months. The dark mottled portions are pieces of unchanged clinker which still show their characteristic markings. Packed tightly about these fragements is a uniform mass of white decomposition products, with an occasional round hole as indicated by the blur in the lower right hand corner of Fig. 1 which shows where a microscopic bubble of air remained in the mixture. The photograph does not show the picture nearly as clearly as it appears to the observer at the microscope. The tensile strength of this briquet broken after three months immersion in water was 770 lbs. and briquets broken after longer immersion up to two years failed to show a higher strength. This might be held to indicate that the reaction had really stopped because no more water could get to the cement. However, a more sensitive test shows that this is not the case.

Expansion of Cement in Water

The lineal expansion and contraction of cement products may be measured with considerable accuracy if they are made into small test bars about one inch square and four inches long with glass plates in the ends.[2] The initial measurement is made when the bar is removed from its mold, usually after 24 hours, and any subsequent changes are measured as variations from this initial reading. The history of the test piece starts therefore, with its second day. An expansion bar was made from the same lot of neat cement as the briquet whose photomicrograph is shown in Fig. 1. This bar has now been in water continuously for 23 years. Measurements of its length were made rather frequently during the first year, and then annually for 15 years with occasional measurements since that time. It expanded steadily but at a decreasing rate for 15 years as is shown by the summary in Table I.

These expansion measurements give a more accurate measure of the continuance of the action of water than tensile tests do. Half of the total expansion occurred in the first two months but expansion was steady for five years and is measurable up to 15 years. A linear expansion of 0.16% may seem small, but when it is expressed as 1.93 in. per hundred feet it gives a clearer comprehension of the expansive force which may result.

Table I—Linear Expansion of Neat Cement Bar When Continuously in Water
Expressed in Percentage Change from Initial Length

7 days	+0.030	2 years	+0.116
28 days	+0.055	5 years	+0.144
2 months	+0.080	10 years	+0.150
6 months	+0.090	15 years	+0.162
1 year	+0.100	20 years	+0.161

This phenomenon of further expansion after the final set is common to all cements which are kept continuously wet. It is greater in neat cement than in rich mortars and is least in lean concretes, because in the first place these have less cement and in the second place they usually contain more voids which may be filled by the expanding colloids without exerting external pressure.

The external pressure developed by this expansion of rich mortars is the cause of the pressure ridges and upheavals which sometimes appear in concrete pavements and sidewalks, as illustrated in Fig. 2. The magnitude of the force required to neutralize the expansion of this bar *83A* may be approximately calculated from the modulus of elasticity which may be assumed as 5,000,000 lbs. for neat cement. If this bar had been rigidly fixed so it could not have expanded it would have exerted a pressure of 75000 lbs. per sq. in. on the restraining ends at the expiration of the 10-year period. Two-thirds of this pressure would have been developed in the first year and the last third would have been more slowly developed in the following nine years.

There is no reason to expect that there will be further

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[2] Campbell and White, *Jour. Am. Chem. Soc.* 28, 1273 (1906).

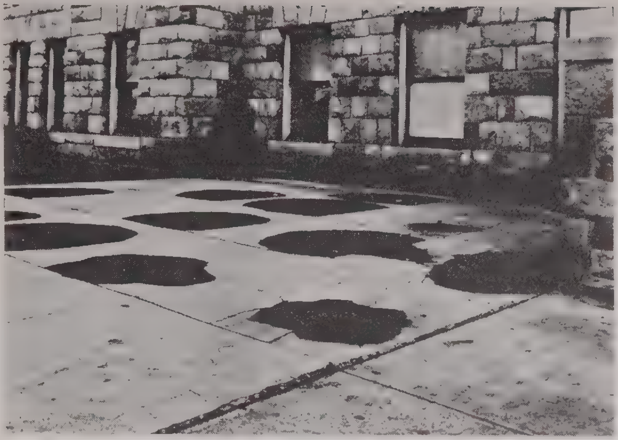


Fig. 6—Warping and cracking of sidewalk slabs due to unequal expansion and contraction of the top and bottom portions

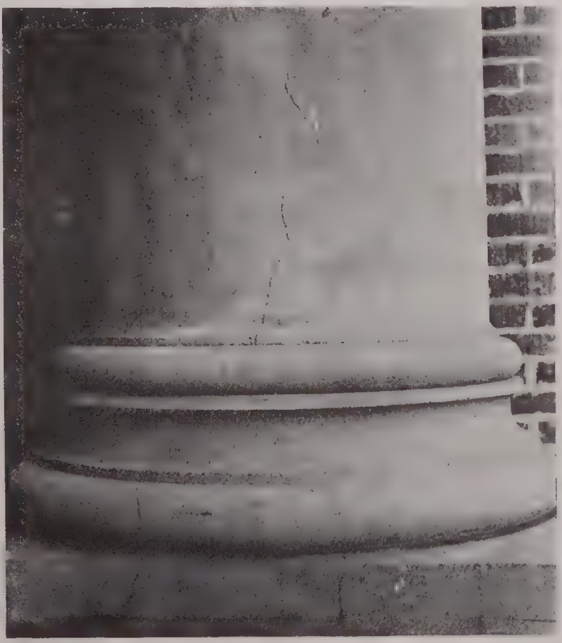
change in this bar of cement if it is kept in clean water and not allowed to become dry. It confirms the usual experience that concrete when properly designed and laid and kept permanently wet may be regarded as a permanent building material. Attention should be called however to the need of allowing for this expansion if the cement is to be kept wet. It is a phenomenon which is inherent in portland cement and cannot be avoided if water continues to act on the cement.

The figures given in Table I refer to neat cement, and the diluting effect of sand diminishes the expansion very materially. There may be trouble with rich mortars as shown in Fig. 2, but there will rarely be difficulties from this cause with lean concretes. The small bars used in these expansion tests are apparently small enough to allow the water to force its way to the center of the bar before the packing effect near the skin prevents further access of water. This is not the case with larger units which may have an expanded outer shell with an unexpanded core and a resulting shear stress between the two zones. The behavior of larger units will be considered later.

Contraction of Cement Products in Air

The foregoing paragraphs do not give any direct explanation of cracked floors and other commonly occurring cracks, but they do explain the reverse process—expansion, and lay the foundation for the explanation of shrinkage cracks. The stiff colloidal jelly which is such an important part of the products formed during the hardening of cement, behaves like clay or glue, in that it shrinks when it is dried and swells when it becomes wet. The rapid development of this colloidal jelly and the importance of its properties are shown by the shrinkage of cement when it dries. The shrinkage in air is from two to three times as great as the expansion in water at the same period. The contraction of a bar of neat cement is shown in Table II. This bar, one inch square and four inches long was removed from its mold after 24 hours, measured and left in the air of the laboratory for 15 years. when it was transferred to a vessel where the air was dried by calcium chloride. By comparison of Tables I and II it will be seen that the bar had contracted 0.085% in 7 days while the bar of neat cement in water required two months to expand that much. In general the contraction in air is from two to three times the expansion in water.

It is this shrinkage of the colloid of the cement which causes such cracks as those in the floor of the room in which I am writing. This particular floor is an illustration of what happens when a person attempts to deviate from recognized practice without a full knowledge of the materials with which he is working. In the construction of this building an attempt was made to deaden the sound transmitted through the floors by covering the structural floor slab with dry sand, with tarred paper over the sand. On top of this unrestrained surface, light chicken wire was placed and then the top coat made of a mixture of one part of cement and two of sand was applied. The floor was kept covered with damp sawdust for ten days and was beautiful when the sawdust was removed. As soon as the floor commenced to dry, cracks formed and grew as the floor dried. Fig. 3 shows the cracks in a corridor of this building. The only way to prevent such cracks is to use a lean mix, which means a soft floor, or to restrain the slab mechanically. If the top coat is bonded firmly to the structural floor slab, large cracks cannot form. The other alternative is the use of adequate steel reenforcement. However, the thin chicken wire used in this particular floor was utterly inadequate. It will be noted from Table II that the shrinkage of neat cement in 7 days is 0.085%. On an assumed modulus of 5,000,000 lbs., the shrinkage stress after 8 days would amount to 4250 lbs. per sq. in., while the tensile strength of the cement would have been little more than one-tenth of that. It is true that the top coat of this floor was not of neat cement but of a 1:2 mix. Experiments on a 1:2 mix have shown a shrinkage of 0.030% in 8 days. Shrinkage cracks in rich



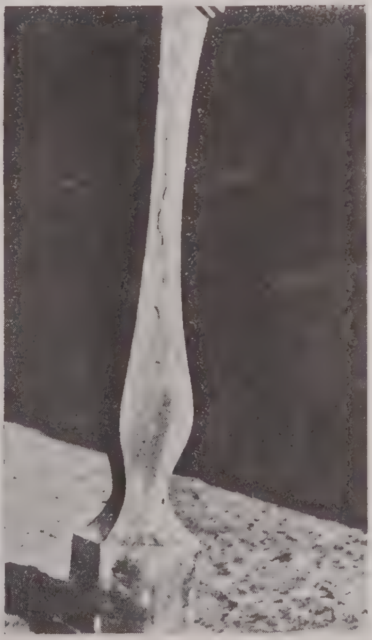


Fig. 5 (Left)—Shrinkage cracks in column in Los Angeles

Fig. 7 (Right)—Cracked light standard at Santa Monica, California. Initial crack due to shrinkage and large crack due to corrosion of steel reinforcement mixtures cannot be prevented by keeping the structure wet until it shall have acquired strength, for the disruptive force also increases with time. This is shown in Fig. 4, which is a photograph of a bar from a series made expressly to illustrate this point. Heavy cast iron frames were made with teeth and bolts at the ends, and spacers inserted along the sides so that when the forms were removed the bar was left entirely free for most of its length but was rigidly held at its ends. The bars are 4 in. square and 42 in. long and contain gauge plugs set 20 in. apart as shown. A free companion bar was cast with each restrained bar and a companion bar is also shown. The bars were kept wet for varying periods and then allowed to dry. All of the restrained bars cracked within two weeks after they were allowed to become dry. None of the free companion bars cracked. This particular pair of bars *157D* were kept in damp air for six months. While they were damp the changes from their initial length were slight. After they were dry the free bar showed a shrinkage of 0.0279 in. over the 20-in. gauge length, or 0.14%. The restrained bar had cracked between the plugs as shown and the plugs had been pulled away from each other 0.0231 in. corresponding to the width of the crack.

Table II—Linear Contraction of Neat Cement Bar When Continuously in Air After the First 24 Hours

Expressed in Percentage change from Initial Length.

7 days	—0.085	2 years	—0.354
21 days	—0.180	5 years	—0.381
2 months	—0.225	10 years	—0.410
6 months	—0.285	15 years	—0.416
1 year	—0.303	20 years	—0.427[1]

[1] In air dried with calcium chloride.

Concrete will always shrink when it becomes dry and the richer the mix, the wider will be the cracks. The remedy is to use a lean mix where strength is not required, as in stucco, and to use adequate reinforcement if it is necessary to prevent cracks in richer mixtures. The method of sidewalk construction in which a walk is cut into blocks of such small dimensions that they are free to shrink without formation of further cracks, is entirely logical and proper. Shrinkage cracks are noted more frequently on flat surfaces like floors and pavements, but columns are not exempt from the general laws. This is illustrated in Fig. 5 which is a photograph[3] of a column at the entrance to a building in Los Angeles. This case is interesting because of the elimination of the action of frost which is sometimes unjustly made the scapegoat in discussions of cracks in cement structures.

Alternate Expansion and Construction of Cement Structures with Change in Moisture

The preceding sections have shown that cement which is kept continuously wet expands slowly as the water eats into the fine grains of cement and that in rich mixtures this slow expansion continues for many years, but finally stops because no more water can force its way into the kernels of unchanged cement. It has also been shown that cement structures which are kept continuously dry shrink and, in the case of rich mixtures, crack because of this inevitable shrinkage. If the cement is maintained in a constant condition of wetness or dryness, constant dimensions are finally reached. The question now to be discussed is the effect of changing from a wet to a dry condition or from a dry to a wet state.

The fundamental factor is that the products formed by the action of water on cement retain their colloidal properties for many years and perhaps indefinitely so that they continue to swell when they become wet and shrink when they become dry. It is not possible to say whether these products ever lose this colloidal property but experiments conducted by the author show that they retain it unimpaired for at least 20 years. Small bars of neat cement will fluctuate 0.2% in length between the thoroughly wet and the dry state. Bars of 1:4 mortar will change about one-fourth of this amount.

When the top coat of rich mortar is bonded to a lean base as happens in floor construction and in pavements the unequal shrinkage of the two layers creates a stress which tends to split them apart or warp the slab. This is well illustrated in Fig. 6 which is a photograph of a cement walk laid with a base of cinder concrete 4 in. thick and a top coat of rich sand mortar 1 in. thick. The top coat in its shrinkage warped the weak cinder concrete base so that each slab became a shallow saucer. Further expansion and contraction with varying weather conditions split the two layers apart in some places and crushed the weak base in others. The trouble here is not to be laid to the cinders but to the weakness of the concrete base. The slabs in the immediate foreground are still in fair condition although they are older than the others. The base of these better slabs was made with gravel instead of cinders and the concrete base was strong enough to resist the pull of the richer top coat.

Secondary Causes of Destruction of Concrete

Expansion and contraction due to temperature is almost always a secondary cause of cracks. The change from winter to summer temperature may be considered as involving a change of 100° F. or an elongation of 0.055%. This is about one-third of the expansion of a rich mortar when it changes from the dry to the wet state at constant temperature. Temperature and moisture may of course give a cumulative effect or may counteract each other. The greatest expansion in concrete pavements will be found in hot and wet weather. The expansion in cool but wet weather is usually greater than in hot but dry weather.

Frost is an important secondary cause of the disintegration of concrete. It has been shown in the writer's laboratory that concrete when properly made and hardened contains practically no liquid water and that the colloid water does not expand on freezing. Sound concrete is therefore not harmed by freezing even when soaked with water. As soon, however, as even a hair crack appears in concrete, a gap is formed which permits liquid water to enter and freeze. The pressure of the ice formed increases the width and depth of the crack and through this ever-widening door disintegration proceeds at an accelerating pace. Even hair cracks must be prevented if disintegration is to be avoided when concrete is exposed in the open air in conditions where ice may form.

Another secondary cause of disintegration of reinforced concrete is the corrosion of the steel imbedded in the concrete. Unbroken concrete of good quality protects steel excellently, but cracked concrete does not protect the steel at all. The expansive power of the rusting steel may burst the concrete. This is shown in Fig. 7 which shows a concrete light standard[4] in Santa Monica, California. It is the corrosion of the steel which has caused the extensive visible damage but the primary cause was a shrinkage crack which permitted water to reach the steel. Here again frost is ruled out as a contributing cause because of the climate.

Conditions for Usefulness and Long Life of Concrete

The properties of cement structures depend, in the last analysis, mainly upon the products formed by the interaction of cement and water. The following principles have been established by experimental evidence:

1. Portland cement hardens through reaction with water, and its properties are dependent on the amount of water and the form in which the water is combined.
2. The process of hardening is a continuous and gradual one. The water starts to react at the surface of each cement grain and works slowly towards its center. The products of reaction form a film which grows continuously thicker and through which the water must force its way to reach the unchanged kernel of cement. The rate of reaction, therefore, becomes progressively slower with increasing time.
3. In dense concretes and rich mortars the reaction with water finally stops because no more water can force its way to the unchanged kernels of cement. This takes a number of years.
4. The material formed by the interaction of cement and water is partially crystalline and partly a very stiff colloidal jelly. Some of the water is held very loosely and a material part of it evaporates

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[3] Furnished through the courtesy of Mr. W. A. Collings, Santa Monica, Calif.

[4] Furnished through the courtesy of W. A. Collings, Santa Monica, Calif.

when the concrete is exposed to the air.¶ This evaporation is accompanied by a critical shrinkage of the concrete. It is the colloidal jelly, especially, which shrinks upon loss of moisture, and swells again on re-exposure to water. It retains this property of expansion and contraction for many years and apparently indefinitely. The conditions which must surround concrete to enable it to attain strength and to maintain this strength are three:

a. The materials must be of good quality, properly proportioned, and mixed with a reasonable amount of water.

b. The concrete must be kept wet long enough to enable the cement to react with enough water to give the needed strength.

c. The moisture content of the concrete must be maintained at a reasonably constant figure throughout its whole life.

Water is the cause of both the life and death of concrete· Reaction of the cement with water gives it strength. Continued contact with good water maintains its strength unimpaired for generations. Removal of the water of combination causes it to shrink and crack. Restoration of the water causes it to swell sometimes to more than its largest previous dimensions. Alternate expansion and contraction due to changes in moisture is the greatest underlying cause of the destruction of concrete structures, for the strains due to the volume changes produced by variations in the water content are usually far greater than those due to changes of temperature. Frost is harmless unless the concrete contains liquid water. Liquid water expands on freezing. Combined water does not. Concrete when properly mixed and hardened does not contain liquid water even though it is immersed in water, for the water which enters the pores of dry concrete becomes combined with the colloid of the cement and loses its power of expansion on freezing.

If concrete is to be permanent, its moisture content must remain relatively constant. It may be wet or it may be dry, or it may possess an intermediate amount of moisture. The absolute quantity of combined water is relatively immaterial so long as it is kept constant. The greatest trouble is found in concrete exposed to the weather. The moisture content of large masses is not uniform and the surface exposed to the weather changes much more rapidly than the interior or the surface imbedded in the ground. There is therefore frequently a differential expansion with a resulting shear stress weakenining the concrete. The strength of concretes is very largely a function of the amount of combined water. A discussion of the effect of the percentage of moisture on strength and the effect of waterproofings on concrete is reserved for a subsequent paper.

American Pyramid a "Sure Bet" Against the Elements

By B. M. Riggs

Actual work has been begun on the foundation of a most unique project—a pyramid of concrete 130 ft. high which will contain records of the achievements of this modern civilization and documents explaining the probable causes of its ultimate downfall. The pyramid is being built in a picturesque valley in the Ozark mountains, near Monte Ne, in Northwest Arkansas, the author and builder being Col. William H. (Coin) Harvey.

The site of the pyramid was chosen after much prospecting. Some locations, ideal in other respects, were not selected because of the great distance to bedrock. The point finally decided upon is at the end of a spur of a mountain at the edge of a valley, the distance to the top of the mountain being about 240 ft. As the valley fills, in the course of time, the pyramid will be submerged until only the top of the shaft may be visible. On the top of the shaft will be placed a plate with this inscription:

"When this can be read go below and find the cause of the death of a former civilization."

Similar inscriptions will be placed below on the exterior walls of the pyramid with the words "go below" changed to "go within."

Every precaution is being taken to ensure the pyramid's standing thousands of years. In the first place, there is, according to geologists, no danger of earthquake action in this region. Also, the Ozarks are very old mountains, having already been reduced from an estimated average height of 14000 ft. to 1400 ft. above sea level. Hence erosion is now comparatively slow.

The Portland Cement Association has donated the services of an expert who will direct the work. The job is to require 14,000 sacks of cement and will cost about $25,000. The pedestal of the pyramid, resting on a natural foundation of solid limestone, will be 40 ft. square and 10 ft. high. Upon this will be a prism with a square base 32 ft. on the side and an altitude of 35 ft. Above this will rise a shaft-like structure 85 ft. high, 22 ft. square at the base, tapering to 6 ft. square.

A retaining wall of rock and concrete, 165 ft. long, has been built on the lower side of the site to prevent any encroachment of water flowing in the valley. Radiating from the site are many tunnels and trenches. Early in the spring of 1924 after the retaining wall had been built, three geologists, attracted to Monte Ne by the uniqueness of Col. Harvey's project, warned him thus:

"You have the plan of the pyramid so that it will last forever, but what about the foundation? In 10,000 years the head waters of a very small spring would wear a hole 20 ft. wide through this limestone formation."

It so happens that close to the site is a spring of no small size, having, in fact, a flow of 6,000 gallons a minute. The tunnels and trenches were dug to locate the source of this spring. It was finally definitely located, missing the site of the pyramid about 12 ft.

Geologists satisfied, then appeared interested persons, native to this region, who locate water by the use of a forked twig. Unscientific as the methods of these "switch engineers" may seem, some ten or twelve of them, at different times, "found" water directly beneath the site of the pyramid. In order that they might be satisfied, 6-in. holes were drilled, every 4 ft., through the limestone rock to a granite rock below, ranging in depth from 20 to 25 ft. These holes were filled with cement grout to stop all crevices, thus preventing any possible flow of water under the pyramid.

In order to preserve the documents within, which will tell of all modern discoveries and knowledge, they will be covered with a waxy, transparent paper. Two books telling of the probable causes of this civilization's downfall will be placed, at a glass factory, in heavy glass containers, the air taken out through a small hole in the glass and then hermetically sealed. There will be three compartments within the pyramid, each containing documents, so that if one compartment is carelessly destroyed when opened, there will still be records left in the other two.

With all these precautions being taken, we shall probably leave for the next period of civilization more of actual value than was left for us by those ancient builders of the Sphinx and pyramids whose knowledge perished with them thousands of years ago.

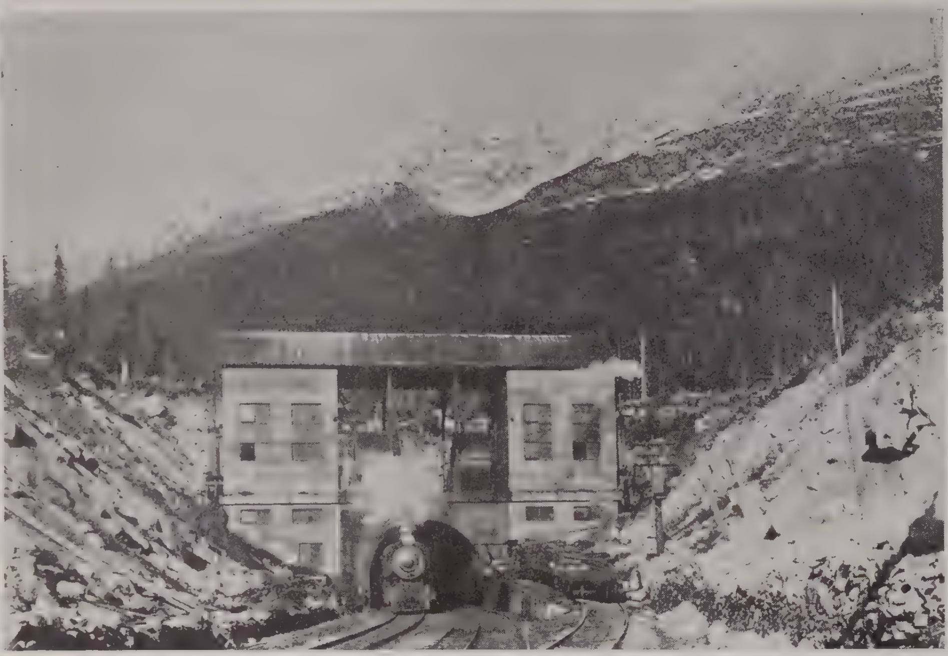


Fig. 1—Western portal, America's longest tunnel, showing fan house

Lining North America's Longest Tunnel with Concrete

The work of lining the five-mile tunnel in the heart of the Canadian Rockies with a reinforced concrete jacket is one of the interesting engineering feats in connection with railroad construction. Beneath 6,000 ft. of mountain, the Connaught double-track tunnel, cuts under Mount Macdonald between the stations of Connaught and Glacier. By running trains through this undergorund shortcut, completed in 1916, the Canadian Pacific Railway overcame many operating difficulties faced on the former route through Roger's Pass. The tunnel did away with curvature in trackage amounting to seven complete circles; the former summit to which trains had climbed was decreased by 552 ft., and the mileage of this trans-continental line where the grade was steepest was reduced by 4½ miles. Four miles of snowsheds on the side of Mount Macdonald were also done away with, all of which was of great value to quicker and safer crossing of the continent by hundreds of trains weekly.

During four years of operating after the tunnel's completion in 1916 the great bore was free of accident. Although the original rock walls promised a continuance of safety, the railway company in 1920 decided to eliminate the remotest possibility of danger by concreting the entire inside of the long hole running under one of the highest mountains of the Canadian Rockies.

By the aid of large motors, air compressors, and four types of collapsible steel forms, the concrete was put in place over the walls and the dome of the great hole. This concrete jacket was made in sections 22 ft. long, each section taking from four to five days to finish. At times considerable blasting had to be done. One day was occupied in filling the forms, and three days allowed for the concrete lining to harden before moving the forms. Six complete sets of forms were used within the tunnel, giving an average of 132 ft. of completed work weekly. At the various working points powerful flood lamps, numbering 100 in all, made the interior as bright as day. A carefully designed ventilating system furnished to all parts of the tunnel the pure air from outside by means of two large steel fans housed at the western portal. They were driven at the rate of 225 revolutions a minute by two 500 h. p. semi-Diesel engines. Thus a steady breeze was created throughout the entire five miles of underground railway, so that passengers suffered no discomfort in passing through, and the workmen remained at their tasks eight hours daily without detriment to health or vigor.

Construction Methods

Nearly 450,000 sacks of Canada cement was used in the lining of the tunnel. Practically all the machinery used in the work was Canadian made, including the compressors and motors. The four types of collapsible steel forms used in the four stages of the lining process came from a Winnipeg plant.

This lining of the tunnel with reinforced concrete has been very aptly described as the building of one tunnel inside another. The difference between the rough surface of the inside as left by the first tunnelers, and the face of the concrete lining varied from a few inches up to several feet, which had to be filled. The concrete lining varies in thickness from 9 in. at the top of the arch to 18 in. at the base of the side footings. The hollow space between the lining and the rock was filled in with lagging, mainly slab ends, before a section of the arch was poured or blown, and the whole concreted in. The finished face of the lining was that left by the surface of the Blaw steel forms, which were made collapsible by means of toggles and turnbuckles, so that they could be lowered and moved forward the length of a section after the concrete had aged.

Between the placing of concrete of a section and the moving of the steel form forward to the new location, what was called the pioneer form was built. This consisted of a framework suspended from the roof and side walls, with the inside, or concave face covered with shiplap, and spaced the correct distance from the face of the steel form when placed in posi-

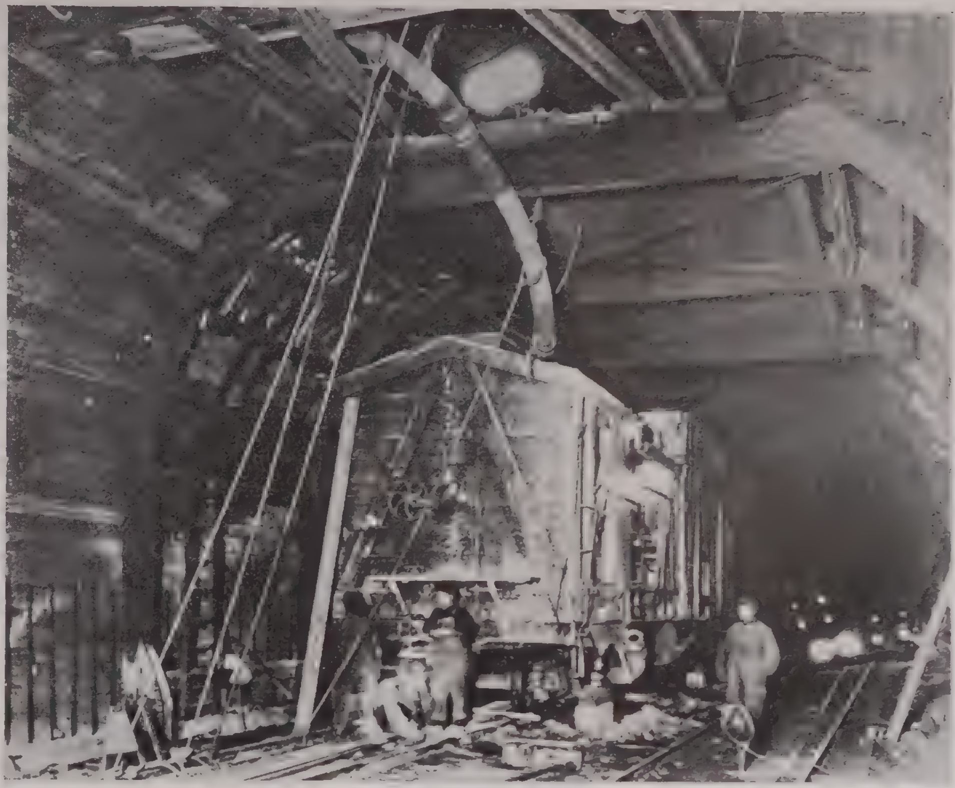


Fig. 2—Concreting America's longest tunnel. Portable equipment used is shown on one of the railway tracks. In the foreground is the pipe through which concrete was blown into the space between forms

tion. This wooden framework was anchored to the rock with steel bolts, wedged in holes drilled in the rock.

The tunnel is double-tracked, and one track was kept free for the heavy transcontinental traffic. To insure against interruption to the lining operation the other track was given over to the use of cars working on the lining. A regular service for the transport of material for use inside was constantly going on for over four years time.

The concrete mixer was mounted on two steel flat cars, and storage for one section was included. The mixed concrete was blown by compressed air through a large flexible pipe, laid before the charge was shot. The staging built ahead of the steel form and from which the pioneer form was built, was used for this purpose, afterwards being again moved forward ready to work from in the building of the next section. The staging as well as the steel forms moved on guide rails at the side of the tunnel. In the locating of these guide rails some very delicate surveying was necessary as a small error might lead to serious results. Both the staging and the steel forms had to be so arranged to provide sufficient clearance for any train to pass clear at any time on the "live track." Whenever a train passed while the work was in progress, the tunnel was filled with smoke, and the work stopped until the air was cleared by the ventilating fans already described.

All equipment was run by electric power. The mixing car was equipped with electric motors, and connection made to the power lines laid in the tunnel all along the length of the space where the six forms were at work. Electric drills were used, and the whole of the working zone was lighted with electric floods. Electricity was transmitted over lines running through the original pioneer tunnel (which was used in the driving of the main tunnel). The necessary power was generated outside at the station of Glacier. When the work of lining was first started over four years ago, a gasoline-driven concrete mixer was used, with acetylene lights instead of electric flood lights. But after a disastrous explosion and fire which tied up traffic for several days, it was decided to use electric current for both light and power.

A complete section of lining was not blown all at one time. The footing walls were first done and after sufficient aging of the concrete, the roof arch was blown. It was early found that the completely filled form was liable to bulge, due to the constant rock pressure from the weight of the rock. The softness of the rock, which aided the original tunneling work, was found to be an unlooked-for adverse condition in the work of lining. The rock is known as talc schist with slate cleavage, and the seams may be very easily noticed in the pieces scaled off. The effect of the air and particularly the moist exhaust of the locomotives was to disintegrate the talc, and the constant pressure of the immense weight of rock tended to make pieces slip or slide out. For this reason one of the first things done before proceeding with the lining was to scale down all threatening pieces. To insure absolute safety men constantly patrolled the entire tunnel, and telephone communications with stations on each side of the tunnel were installed at half mile intervals.

The Sydney Jankins Co., construction engineers, Vancouver, B. C., were in charge of the lining operations.

Methods used for supporting flat slab bars near the top of the slab include precast concrete blocks and proprietary supports such as the sheet metal or wire supports available on the market. It is sometimes contended that if the bars are long, the sag in the center of the span is sufficient to bring the steel into the proper location in the section of the floor. At the column, the steel may be supported on the stub of the column without additional support. A cure for the cracks which develop as the concrete shrinks around concrete block or metal hangers is to use as little water as possible in the mix.

The use of high alumina cement has been found particularly economical in patching concrete floors in occupied buildings. The early development of high strength of alumina cement concrete permits the minimum interruption of the use of the floor.

Safety for Concrete Workers on 26-Story Building

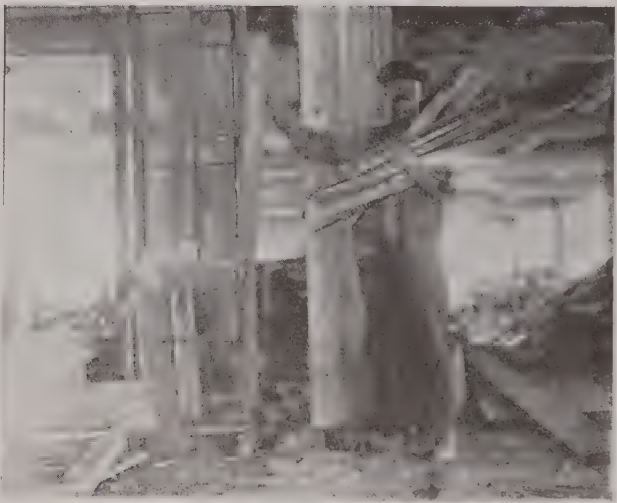


Fig. 1—Wooden chute passing through light well through which wood and debris are thrown

The accompanying photos show some of the safety features for the concrete workers which were used in the construction of the new 26-story building of the Pacific Telephone and Telegraph Co., in San Francisco, in the construction of which there was not a fatality or serious injury to any of the workmen.

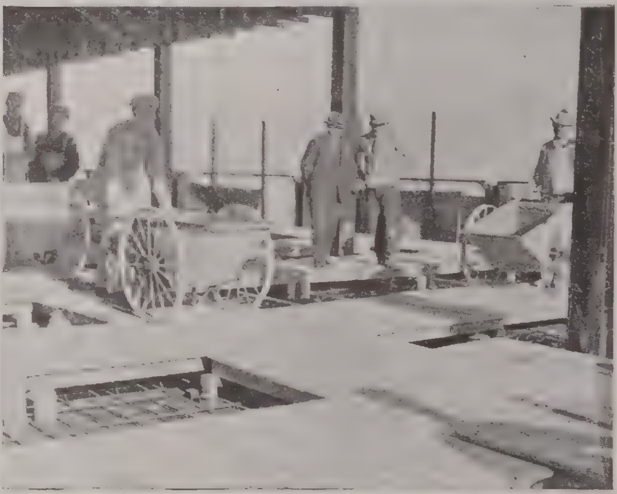
Two passenger elevators were installed for the purpose of conveying all workmen to and from the various floors, no workmen being permitted to ride in any of the material elevators. An experienced elevator operator was in charge of each passenger elevator, and only 12 employees were permitted in an elevator at one time. The passenger elevators were operated in the permanent elevator shaft, at a maximum speed of 250 ft. per minute, this having proved the most desirable speed under the conditions for perfect safety. Wooden enclosures 8 ft. high guarded the elevator shaft at each floor. The workmen entered the elevator through a wire mesh door 6 ft. high which was latched from the inside. This door could only be opened by the elevator operator, thus it was practically impossible for a workman to fall down the elevator shaft or to be struck by a passing elevator. A safety folding steel gate, installed on each elevator was closed by the elevator operator each time before starting the elevator cage. The elevator cage was entirely boarded up and had a heavy roof to protect those riding therein from falling material.

All mortar was hoisted to the various floors by means of specially designed material elevators. Signals were given to the engineer who controlled the hoist for the material elevators by means of electric bells and push buttons, the push button being installed on the elevator. Signals could not be given unless the authorized elevator starter was at the elevator. In addition to the bell and push button signal, a red light was located in front of the engineer and controlled by a push button placed on each floor near the elevator. In case of emergency, this button could be pushed, lighting the red light, when the engineer would instantly stop the elevator, thus avoiding possible accidents.

A very unique feature was the installation of telephones on the various floors which could be used in calling an ambulance in case of accident. It might require some little time in carrying an injured workman from the upper floors to the field office, when by means of the telephone an order could be given for an ambulance, which could be making the run to the building while the injured man was being taken to the field office.

Pedestrians were protected from being spattered when concrete was being poured, by heavy tarpaulins tied between floors at the edge of the building. This proved very effective especially in case of a high wind.

Injuries are sometimes received by workmen and pedestrians



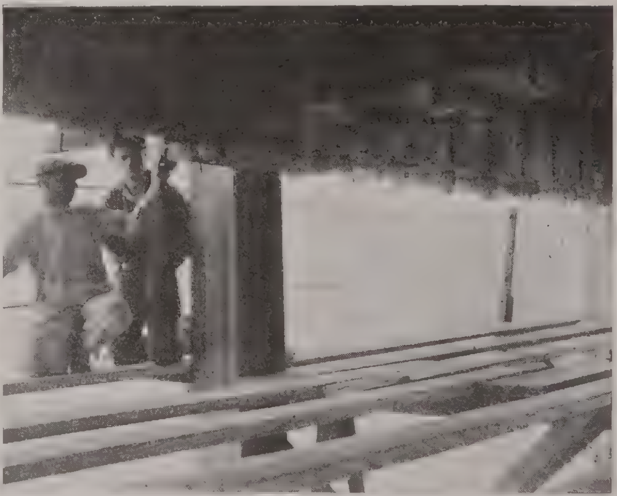
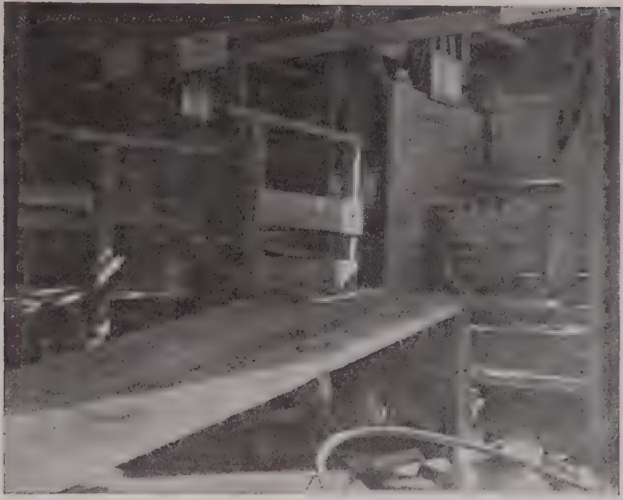
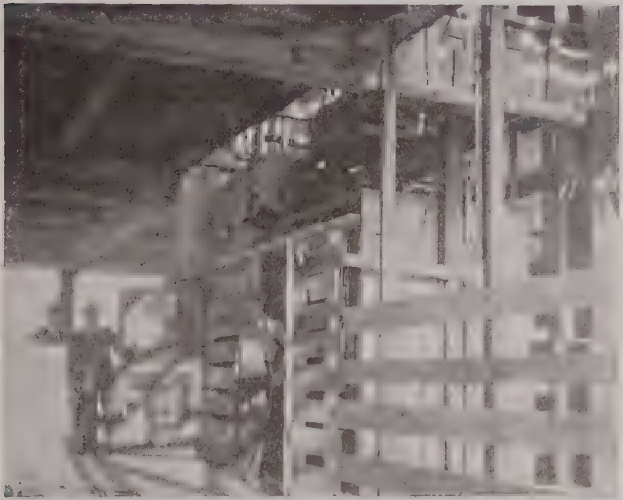


Fig. 2—Showing the well constructed platform for pouring concrete floors. J. J. Rosedale, the safety engineer, is seen standing directly in front of the steel column

Fig. 3—Outriggers scaffold used for stripping forms. Note how the men are protected by rope railings





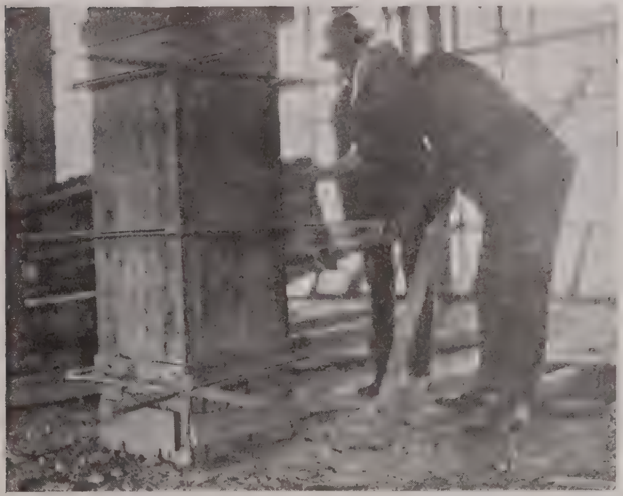


Fig 4—The elevator for elevating mortar

Fig. 5—Two passenger elevators carry the employees to and from the various floors. Note the wire mesh door and the safety folding steel door

Fig. 6—Showing column clamp and the tapered wedge which holds the form absolutely tight and rigid. The notches in the clamp enable it to be used on any size column

from being struck by pieces of wood and debris when material is being lowered from the upper floors. To eliminate this hazard a large wooden chute was erected inside the building and connected to every floor. All debris and pieces of wood were promptly thrown down through this chute as soon as there was no further use for them.

Portable scaffolds used by carpenters, to tighten the form work were provided with a railing extending around three sides of the scaffold, thus preventing a workman from falling off. One of the accompanying illustrations shows an outriggers' scaffold used for stripping forms, which was protected by rope railings, designed to keep the men from falling off.

Fig 2 shows the specially designed and well constructed wooden platforms for pouring concrete floors. In this photo can be seen J. J. Rosedale, the safety engineer who was engaged by the contractors, Lingdren & Swinerton, Inc. to install every safety feature possible.

In pouring the columns metal column clamps devised by the superintendent of construction were used. This metal clamp will fit any column box and because of the tapered wedge will hold the form absolutely tight and rigid. Its cost is approximately half that of the wooden clamp and its use saves the time of one man watching for burst column boxes while pouring concrete. It also saves time in forming and stripping and holds the form to a perfect rectangle.

New Books

Reinforced Concrete Beams in Bending and Shear, by Oscar Faber, Size 6 in. x 9½ in.; cloth binding; 160 pages; Concrete Publications Ltd., London, England, 9 shillings.

This book is presented as including a verification of the resistance of singly reinforced concrete beams and the determination of the relative value of two proposed methods of calculating beams having compression reinforcement. It also includes a new treatise of shear in concrete beams and new rules and formulae having a scientific basis and being of such a form as to be conveniently used by engineers. The results of the new formulae suggested are compared with three separate series of test beams, the experiments having been carried on to prove the scientific basis of the new formulae. The book contains a statement of the usual theory and the formulae derived from it for the design of reinforced concrete beams.

The Concrete Year Book, 1925, edited by Oscar Faber and H. L. Childe, London, England. Concrete Publications, Ltd.; price 3 shillings; size 5½ in. x 8½ in.; 400 pages.

The handbook section has been revised and many new chapters added. Notes and authoritative articles are given on the construction and a great deal of memorandum of every-day use included. Standard specifications and design tables for various structures are also given. The essential factors in making good concrete are taken up in the order: cement, aggregate, water, workmanship and atmospheric conditions.

The directory section has been enlarged and comprises particulars of every business connected with or catering to the concrete industry. A complete list of trade names and brands with the names and addresses of their proprietors has been added.

A catalog section of 180 pages contains full particulars of business and products of interest to those seeking contractors to undertake special work on machines or products for special purposes.

Simple Examples of Reinforced Concrete Design, by Oscar Faber, size 5½ in. x 8½ in.; 84 pages; price 5 shillings ($1.70); Oxford University Press, London.

This is a companion volume to the book *Reinforced Concrete Simply Explained*, by the same author and contains simple and clearly written practical applications of the principles of elementary design.

The book is divided into chapters under the following headings: Circular Water Tank, Small Square Tank, Floor Slab and Beams; Warehouse Floor on Concrete Columns; Retaining Wall; Water Tower; and appendix notes on Moments in Pillars. The various problems illustrated are well selected to give a foundation in the theory of concrete design.

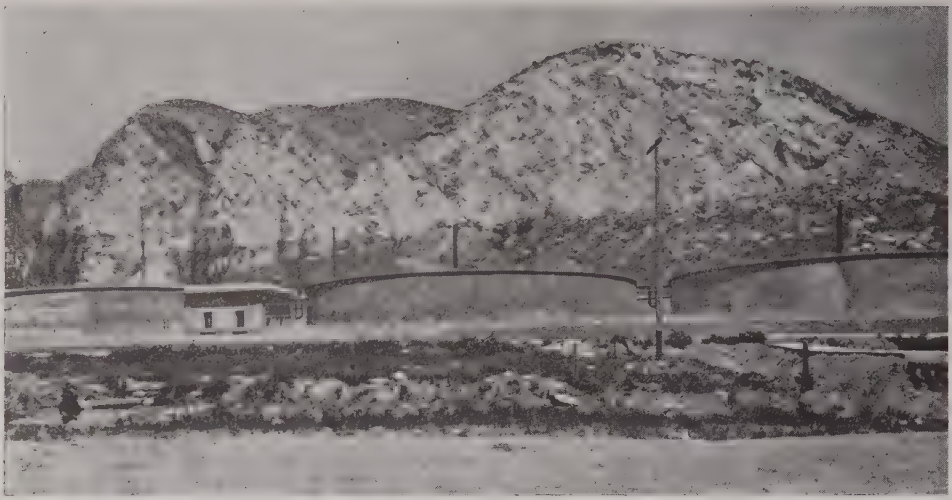


Fig. 1 — California Portland Cement Co., Colton, Calif. View of completed fuel oil tanks and pump-house with quarry in background

Oil Storage Tanks of Unusual Design

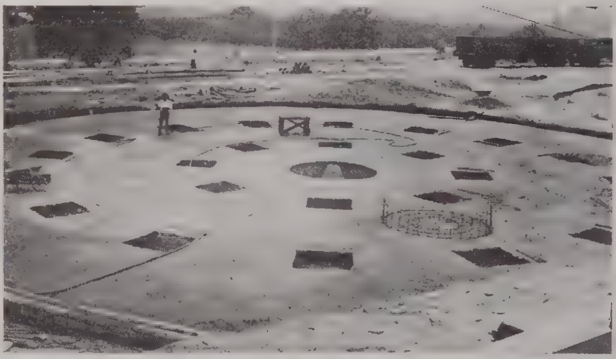
By Warren Travell
Chief Engineer California Portland Cement Co.,
Colton, Calif.

During the years 1922 and 1923 the California Portland Cement Co. remodeled and rebuilt its plant at Colton, Calif., to increase the output. This required an additional fuel-oil storage of about 60,000 bbls. and it was decided to build three concrete tanks of 20,000 bbls. capacity each.

A study of the difficulties encountered in existing reinforced concrete tanks of considerable size indicates that leakage in such tanks is mainly due to the cracking of the concrete. This cracking is partly the result of shrinkage during construction but is more especially due to excessive tensile stresses arising from internal pressure. As these cracks increase in size upon the application of internal pressure and close upon the removal of such pressure, it is difficult to remedy the defect by the application of coatings to the interior. Another difficulty encountered in such structures is the making of a tight joint between the floor and side-walls. If the tank is, say, 100 ft. in diameter and a unit working stress of 16,000 lbs. per sq. in. is used for the steel, the side walls will move about 5/8 in. under the full pressure. A joint that will permit this movement and remain water-tight proves a difficult problem. If the side walls are tied securely to the bottom of the tank, the result is excessive bending in the side walls, causing horizontal cracks. Even with a satisfactory joint at the bottom of the side walls, the concrete in these walls must crack before the steel can be subjected to a considerable stress in tension. By placing the bands under an initial stress, all tension in the concrete may be avoided and the problem of joining side walls to the bottom becomes very simple.

A working unit tension of 16,000 lbs. per sq. in. of steel has been successfully used in reinforced concrete beams. While the concrete in such beams cracks near the center, these cracks must be minute since the compressive side of the beam prevents large cracks within the working stress of the steel. The rods in the beam are anchored in solid concrete undisturbed by the cracking. In the side walls of a storage tank, built according to common practice and subject to internal pressure the conditions are quite different as all parts of the wall are in tension. This may result in large cracks and a very serious disturbing of the bond. In existing tanks, partial failure has frequently caused the spalling off of the concrete on a vertical line through the bands.

The placing of the bands under an initial stress has the following very important advantages: first, shrinkage stresses are eliminated; second, all of the concrete of the side walls being in compression, no concrete is subjected to tension; third, the change of stress in the steel bands, due to internal pressure, is very small. The bands when placed are given an initial stress of about 85% of the ultimate working stress and the change in stress is, therefore, not over 15% of what this change would be if the bands were placed in the concrete in the usual way.



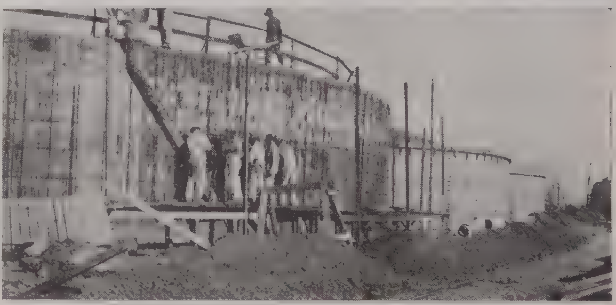


Fig. 2—Foundation all ready for concrete. The laborer is thoroughly wetting the ground before concrete is poured

Fig. 3—Pouring first ring of circular wall. Note the 5 laborers puddling the concrete to increase its density

Unloading Equipment

The three storage tanks are so located on a side hill that oil may be delivered to them by gravity from tank cars on two tracks at a higher elevation. Ten concrete receiving boxes, each 6 ft. long and 2 ft. wide, were built between the rails. These boxes are located 40 ft. apart and discharge to a concrete conduit between the tracks. At the end of this conduit, is a concrete distributing box equipped with fire-stop, screen, sand trap and control valves.

Tank Details

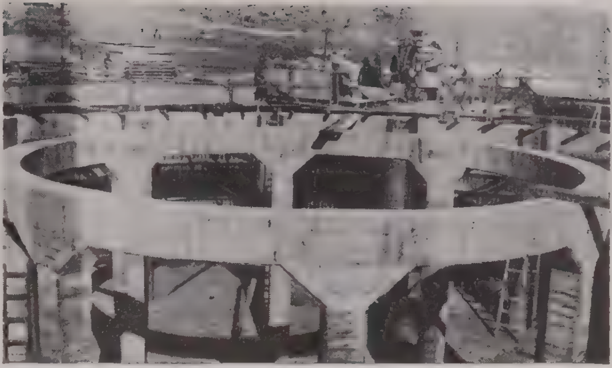
The three tanks are duplicates in all respects except pipe connections. The inside diameters are 94 ft. 8 in. at the bottom and 95 ft. 4 in. at the top. Sidewalls are 17 ft. high or 16 ft. from floor to flow-line of the overflow pipe. The walls are vertical on the outside, 12 in. thick at bottom and 8 in. at top inside the steel hoops. The reinforcement of the walls consists of vertical rods, ½ in. diameter, spaced 18 in. apart, and external, circumferential tension rods varying from $\frac{29}{32}$ in. diameter, 2⅝ in. apart at the botton, to $\frac{9}{16}$ in. diameter, 18 in. apart at the top.

Excavations were made to the required levels and the footings for sidewalls and roof columns placed. The floor slab was next concreted, sloping to a large sump pit at the center. The roof columns and beams were then built to provide bracing for the sidewall forms. The inside forms for the sidewalls were made the full depth of the wall and in 32 sections, each about 9 ft. in width. These were set in place and securely braced to the columns and beams. The outer forms were also built in 32 sections but were made in three lifts, each about 6 ft. in height. This permitted thorough puddling of the concrete. After the concrete in the first section had been in place for a few hours, the top of the concrete was thoroughly cleaned of laitance by the use of wire brushes and water. The following day the next lift of the outside forms was assembled ready for the placing of another ring of concrete on the following day. In this way, five days were required for building the circular wall of each tank.

Tightening of Rods

As soon as the forms for the sidewall were removed, the work of assembling the adjustable rods was started. Each band was made up of 8 rods, about 37 ft. long, connected by standard turnbuckles. Recesses had been molded in the outer surface of the wall to provide clearance for the turning of these turnbuckles. The rods were so assembled that in tightening the turnbuckles the levers used for the purpose were always moved down. These levers were of different lengths, being proportioned to the size of the rod, the stress required and the weight of the man who was to use them. The work of assembling and adjusting these bands is the same as is required in banding wood pipe or wood-stave tanks. The bands were provided with rolled threads instead of upset ends and cut threads, as the section of rod where the threads were rolled was found to be stronger in tension than the body of the rod. This permitted the use of smaller turnbuckles and effected a considerable saving in cost. In order to use standard turnbuckles, odd sizes of rods were used. A rod of $\frac{29}{32}$ in. diameter rolls a thread to fit a 1 in. standard turnbuckle, a $\frac{9}{16}$ in. rod rolls to ⅝-in. thread, etc. The rods used were of rivet steel with a yield point of 36,000 lbs. per sq. in.

In tightening the bands, an effort was made to get fairly uniform results and to get an initial stress in the steel that would result in zero stress in the concrete at the base of the tank walls when under full pressure. This initial stress was found to be about 12,500 lbs. per sq. in. and all rods were stressed as nearly as possible to this amount. When the tank is under full pressure, the unit pressure in the steel increases to about 16,000 lbs. per sq. in. with no stress in the concrete. It will be noted that the total change of stress in the steel is only about 3,500 lbs. and that there is no tension in the concrete at any time.



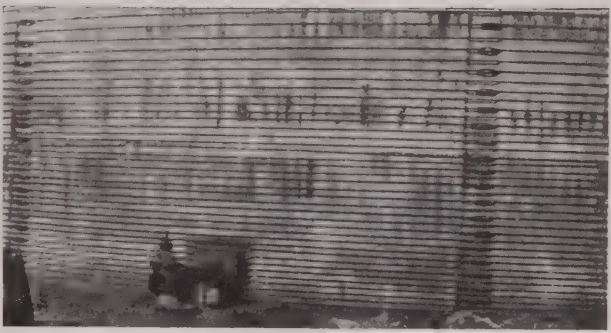


Fig. 4—Interior columns and circular beams for supporting roof

Fig. 5—External tension rods in place

Lining of Tanks

As soon as the adjustable rods were tightened on a tank, it was filled with water. There were no leaks of any importance but where damp spots appeared on the outer surface, the inner surface was treated with a mixture of steel dust and cement. When the tanks were entirely water-tight and moisture-proof, they were given two coats of gunite on the outer surface of the side walls and a thin coat on the inner surface. The outer gunite coating was altogether about 1½ in. thick, carefully placed under the bands to give additional bearing, and thick enough to protect them from corrosion.

After the middle tank was completed and had received its coatings of gunite, strain-gage measurements were taken on the side walls at several points. These points were about 30 in. apart and located in a vertical line on the north side of the tank. Readings taken before and after filling with water showed practically no variation. All tanks were filled with water after completion and allowed to thoroughly cure before being used for the storage of oil.

Roof Details

The location of the tanks is but a short distance from our limestone quarry and about one hundred feet below the level of the quarry floor. On account of the danger from flying stones, the roof was made 8 in. thick and heavily reinforced. It was built in thirteen separate sections, resting on the side walls and upon circular beams supported by interior columns, the intention being that, in case a heavy stone should fall upon the roof, it would damage only the slab which it strikes, with no injury to the remainder of the roof.

Concrete Materials

An unusual feature of the construction is that no sand was used in the concrete, its place being taken by stone dust which had passed through a ¼-in. square wire mesh screen. Careful tests and previous use of this material in concrete construction at this plant indicated that the substitution of limestone dust for sand improves the strength and density of concrete rather than otherwise. The proportions used in mixing were one part Colton cement, 1.4 parts crushed limestone passing a ¼-in. screen, 1.4 parts crushed limestone passing a ¾-in. screen, and 2.0 parts crushed limestone passing a 3-in. screen. The resulting concrete is very dense, weighing about 160 lbs. per cu. ft. Exceptionally high values are also obtained in the tensile and compressive tests. With a somewhat leaner mixture, consisting of one part Colton cement, 2.36 parts limestone, dust to ½-in., and 4.64 parts of ½-in. to 2-in. limestone, the following results were had by a well-known testing laboratory:

40 days old, 3,759 lbs. per sq. in. in compression;
1 year old, 4,403 lbs. per sq. in. in compression,
1 year old, 4,403 lbs. per sq. in. in compression;
8 years old, 5,324 lbs. per sq. in. in compression.

A mixture of one part cement to three parts limestone screenings, ¼-in. to dust, showed a tensile strength of from 600 to 1,000 lbs. per sq. in.

MEASURING GAUGE

For measuring the height of oil in the tanks, rigid gauges were installed with floats of extra large size. These proved to be very sensitive and accurate in operation, registering, the oil level within $\frac{1}{16}$ in. These gauges have now been in use more than a year and work as smoothly and accurately now as when first installed.

The three tanks were completed early in January, 1924, and on being filled with oil showed no leaks nor dark spots on the outer surface. The accompanying illustrations show quite clearly the various stages of construction and the completed work.

All of the work of construction was done by the company's own forces under the writer's direction. William S. Hewett, Minneapolis, Minn., the inventor of this system of tank construction, was consulted in the design and execution.

Cast Iron Bridge Reconstructed in Ferro-Concrete

By Major Johnstone-Taylor
ENGLAND

An example of the use of ferro concrete in the reconstruction of a cast iron bridge is seen in the accompanying diagrams which refer to a road bridge in North Wales of 105-ft. span. The bridge in question built some 110 years back on the then prevalent arch rib system having become unsafe for modern loads, the question arose as to the feasibility of retaining the general form of the old bridge mainly for historic reasons and it was finally decided that this could be done by embedding the original ribs in the new ferro concrete ones. The latter are designed to take the whole of the load such added strength as the cast iron ribs afford being disregarded.

At the same time the appearance of the original bridge is essentially maintained, including the retention of the outer ribs as they were. Of the five ribs therefore, which have a thickness of 2 in. and a depth of 2 ft. 6 in. at the crown, the three inner ones are now embedded in ferro concrete the two outer of these *a a* Fig. 1 being the load carriers, rib *b* being merely encased. Fig. 1 which is a cross section at the crown and Fig. 2 a cross section between crown and abutment show the general method of construction. The spandrel walls *c* are carried up to deck level and in them are encased the original cast iron lattice work which supported cast iron plate decking, the latter now removed. The stiffening beams *d* have a cross section of 30 in. x 16 in. and encase the original cast iron struts in this position, six in all.

The decking *e* is 7 in. thick and it is carried upon the secondary beams *f*. These which have a section of 21 in. x 8 in. rest upon the spandrel walls and are shown in Fig. 3 while Fig. 2 shows the method of extending these in the form of cantilevers as at *g g* to the back of the original cast iron outer ribs *h h* which are retained exactly as they were. Beyond these ribs are the footways so disposed as to allow of a 20-ft. width of roadway. This introduces the matter of the longitudinal beams *j* 6 in. deep x 7 in. wide. These were necessitated by the fact that the footways had to be arranged as cantilevers, self supporting, because of the impossibility of taking any beams through the outer ribs. The original iron railings are disposed at *k*; originally they were above ribs *h h*.

Attention is now directed to the somewhat massive beam *l* in Fig. 3. The cast iron ribs terminate against the abutment plate *m* on the original masonry *n*. The latter is retained in its original form with the addition of a mass concrete backing *p*. The beam *l* having a mean section of 6 ft. x 2 ft. runs the whole width of the abutment, encases the original base plate *m* and serves to distribute the load from the ferro concrete ribs with an intensity of pressure of 7 tons per sq. ft.

Altogether the work is one of considerable interest incorporating as it does a modern utility structure while retaining the original appearance of the bridge which in view of the locality being one frequented by tourists, is an important matter. The cost of the work is stated to have been about £8500.

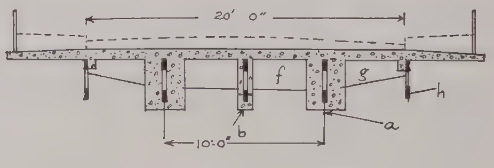


Fig. 1

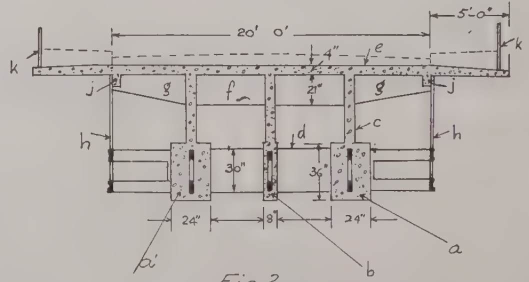


Fig. 2

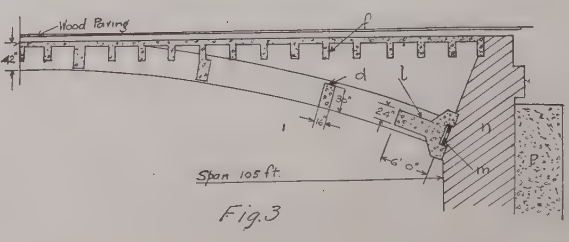


Fig. 3

Estimating and Cost Keeping for Reinforced Concrete Building Construction

That it is a matter of common knowledge that a large number of reinforced concrete building contracts were entered into during 1923 on a basis which failed to yield a profit to the contractors is pointed out by a committee studying estimating and cost keeping for reinforced concrete building construction in a report in *Building Congress News*, issued to members of the New York Building Congress. The committee is composed of Henry H. Fox, Turner Construction Co., Richard L. Ahern, Barney-Ahlers Construction Co., A. E. Budell, Industrial Engineering Co., and J. W. Escher White Construction Co. It is reported that four or five contractors have practically withdrawn from the market on account of losses suffered in 1923. These losses may have been in part due to inefficient handling of the work, but it is probably true that a large amount of work was contracted for at figures which could not possibly have yielded a profit even under the most able management. The causes may be classified as follows, according to the committee:

1. Lack of knowledge of costs.
2. Errors in estimating.
3. Failure to foresee conditions in labor and material markets.

Lack of Knowledge of Costs

One contractor may estimate too low because he has not had enough experience in reinforced concrete construction to know what it costs. Another contractor may have had considerable experience but may have kept such incomplete cost records that his experience is of little value in estimating new work. In either case, the result is the same; a loss to the contractor who does the work and a loss to some other contractor who might have secured the work at a fair price.

Cost records are of no value—or at least of very little value—unless they are the product of a cost-keeping system which is complete, and subject to the same rigid balancing requirements as a first class bookkeeping system. A unit cost for placing reinforcement which is obtained by dividing the total cost for one day by the total tonnage placed that day is of no value for two reasons; first, there is no check on either the total cost or the tonnage; and second, the resulting unit cost is a special cost for one day and not an average for the job. An average unit cost for a job may easily be twice as great as a unit cost for one day taken when the job is under full headway. Under a proper cost-keeping system all expenditures for the account of a given contract must be charged against that contract, and the charges must be properly classified; the cost of all labor, every item of materials, and all sub-contracts, and other expenses of whatever nature must appear under the proper classifications, and the sum of the amounts under all the classifications must equal the total cost of the work as it shows on the books.

The "other expenses of whatever nature" referred to in the previous paragraph are often sadly neglected in putting together an estimate. How many estimates include allowances for temporary power wiring, temporary water piping, job telephone and telegraph charges, job traveling expenses, tool-house man, and wear and tear on plant, not to speak of the many items covered by the all-embracing term "overhead."

By the term "overhead" we do not mean field organization, insurance, or definite items of that nature, which cannot be omitted from any intelligent estimate except through gross carelessness. We refer to main office expenses the classification of which is open to argument. There are two kinds of "overhead" expenses: (a) expenses which do not fluctuate immediately with the volume of business, such as rent, salaries of officers, heads of departments and other steady time employees, depreciation and taxes; (b) expenses which fluctuate with the volume of business, such as salaries of draughtsmen and clerks, telephone and telegraph charges, blue prints, stationery, postage, interest on bank loans. There is room for difference of opinion as to whether items under (a) should be covered by a specific allowance in every estimate. There can be no denial that the items under (b) are as real a part of the cost of the work as labor and materials used on the job. On average work the cost of these items is from 1 to 2 %.

The cost of winter weather protection is often given insufficient consideration. During the winter of 1923-1924 there were at least three serious failures of reinforced concrete attributed to lack of proper winter weather protection. This is not only bad for the individual contractor but bad for the industry. It is a simple matter to figure out the cost of canvases necessary to enclose a sufficient area of the work, the cost of salamanders and coke and the rental of a boiler for heating the water and dry aggregates. The cost of labor can be estimated only by experience. The four construction companies whose representatives are signing this report will gladly furnish information from their own experience to any contractor desiring to protect his work properly under winter weather conditions.

2. Errors in Estimating

These errors fall into two classes:

(a) Clerical errors either in quantities or in extensions.

(b) Failure to interpret specifications.

(a) Clerical errors are due to carelessness and inexperience on the part of an estimator, or failure to have estimates checked. It is fairly easy to make a mistake of $10,000 in an estimate. A small part of this sum added annually to the budget of an estimating department would make the risk of such a mistake almost negligible. Employ good estimators and have their arithmetic checked by another man.

(b) The amount of gamble which many contractors are willing to take, either consciously or carelessly, through bidding without reservations on an ambiguous or unfair specification is surprising. A city job involving over two million dollars came out for bidding during the past winter. Several clauses in the specifications were ambiguous, and three of four days before the opening of the bids one of the signers of this report wrote to the department in charge of the work asking seven questions, all of them so important that the nature of the replies would affect the estimate to the extent of about $100,000. These questions were answered in the form of a bulletin sent to all contractors bidding, and the form of the bulletin was such that it was evident that none of these questions had been asked by any other bidder.

It seems to be the case that many contractors turn over plans and specifications to an estimator without having them studied by a responsible executive; or if such a study is made, it is made just before the bid is submitted when time is lacking to develop a clear picture of the problems involved. No contractor can safely submit a bid unless specifications have been read and plans studied thoroughly by an experienced and responsible executive.

3. Failure to Foresee Conditions in Labor and Material Markets

It is possible for a bidder to protect himself by firm quotations from material dealers and subcontractors on practically all materials and subcontracts entering into an estimate. He cannot protect himself against labor troubles, labor inefficiency, and delays due to shortage of materials and labor and other causes. The best he can do is to try to foresee the conditions which will affect the supply of and demand for labor and materials at the time when the work will be under way. Fortunately the information upon which he can base such a forecast is more easily available than ever before, and is being published by various sources in such a form that it can be interpreted without the aid of a statistical expert. Contractors should form the habit of studying conditions affecting the building industry. If they had had this habit in 1923, when a clear warning was sounded of the trouble ahead, there would have been less grief when the annual reports were completed.

Report No. 2 of Committee Appointed to Study Estimating and Cost Keeping for Reinforced Concrete Building Construction

A former report submitted by this committee dealt with the fundamental principles of sound estimating. Report No. 2, dated December 1, 1924, discusses details and suggests a series of headings or classifications to cover all the individual items of cost which when combined constitute the total cost of a typical reinforced concrete building. Such a series of classifications should be of assistance to contractors in preventing errors of omission in estimates. The general adoption of these classifications would also provide a common language for the interchange of cost information and might ultimately lead to the taking off of quantities by a central bureau thus eliminating a great waste under the present system when quantities are taken off independently by all contractors figuring any given project.

1. Clearing site:
   - Buildings
   - Trees.
2. Excavation:
   - Accurate information on present grades.
   - Character of Soil.
     - Rock—line drilling—leveling.
     - Boulders.
     - Old Foundations.
     - Sticky clay or mud.
     - Between piles.
     - Subsurface obstruction (particularly on waterfront work).
   - Water.
   - Sheet-piling.
   - Backfilling.
   - Finished grading.
   - Excavation for plumbing, heating, electric and sprinkler lines.
   - Where disposed of?
   - Cost of dump.
3. Fill:
   - Cinders.
   - Earth.
   - Sand.
   - Gravel or broken stone.
4. Shoring and Underpinning:
   - Accurate information on present depth of foundations to be underpinned.
   - Investigate character of soil under walls to be underpinned and condition of walls.
   - Repair damage to buildings underpinned including cellar floor.
5. Piles:
   - Rigidity of specification.
   - Responsibility for length.
   - Responsibility for bearing value.
   - Responsibility for grade of cut-off.
   - Who pays for waste in cut-off?
   - Who does capping?
   - Must footing excavation be done before pile-driving?
   - Follower permitted?
   - Pulling old piles.
6. Foundations:
   - Responsibility for bearing value of soil.
   - Responsibility for grade of bottoms.
   - Additional cost of working around needles and braces.
   - Cofferdams.
   - Grouting column bases.
7. Concrete:
   - a. Cement.
     - Trucking.
     - Unloading.
     - Bag loss
     - Testing.
     - Large storehouse if 28 day field tests specified.
     - Factor varies with nature of aggregate.
   - b. Sand and Stone
     - Quality satisfactory?
     - Trucking.
     - Receiving.
     - Do working conditions require purchase in small quantities from local dealers?
     - Testing.
     - Ready mix permitted?
     - Are quotations per yard or per ton?
     - Quantities will be short if bought by truck-load.
     - Factors vary with nature of aggregate.
   - c. Water.
   - d. Power.
   - e. Integral waterproofing.
   - f. Roof grading.
   - g. Labor.
     - Foundations.
     - Columns and floors.
     - Walls.
     - Miscellaneous work—stairs sills, coping, etc.
     - Overtime cleaning up and preparing for next day's work.
     - Shifting chutes and runs.
     - Special union rules.
       - Concrete foremen.
       - Brick foremen.
       - Lather foremen.
8. Reinforcement:
   - Base price.
   - Freight.
   - Extras
   - Trucking.
   - Unloading and sorting.
   - Bending.
   - Hoisting.
   - Placing.
   - Tie wire, chairs, spacers, etc.
   - Early deliveries from stock.
   - Testing.
   - Working drawings.
9. Forms:
   - a. Materials.
     - Lumber.
       - Are specifications rigid as to quality of lumber and number of re-uses permitted?
     - Quantity required and number of uses.
     - Trucking.
     - Unloading and sorting.
     - Waste.
     - Replacement.
     - Mud sills.
   - Steel column forms.
   - Steel floor forms.
     - Effect on cost of pointing.
     - Increased cost of beam forms, stoppers, etc. not included by steel form subcontractor.
   - Nails.
   - Bolts.
   - Grease.
   - Flashing strips.
   - b. Labor.
     - Making panels, beams, or other units, per M'BM.
     - Setting in place.
     - Re-shoring.
     - Stripping.
     - Lowering from roof.
     - Breaking up.
     - Increased cost of high or varying story heights
     - Increased cost of long span or deep girders.
     - Ornamentation.
10. Floor finish.
    - Hardener.
    - Rain protection.
    - Sawdust and wetting.
    - Guarantee—terms and duration.
    - Overtime if large areas.
    - Preparing surface for finish.
    - Additional labor and material if laid later.
    - Coloring matter.
    - Excessive jointing.
11. Surface finish:
    - Interior.
    - Exterior.
    - Scaffolding.
    - Special material.
    - If specification is ambiguous or unreasonable, qualify bid by setting up some existing building as standard.
12. Inserts and sleeves:
    - Do union rules permit setting by general contractor?
    - Special accuracy required in setting?
13. Brickwork:
    - Quantity affected by size of brick.
    - Quantity of Face brick affected by bond, backing and reveals.
    - Trucking.
    - Unloading and piling.
    - Mortar.
    - Mortar color.
    - Mortar tubs.
    - Scaffold plank and horses.
    - Rental of patent scaffold.
    - Winter protection.
    - Hoisting and distributing.
    - Laying.
    - Washing down.
    - Ties.
    - Ground or moulded.
    - Paneling and special work.
    - Non-staining cement.
    - White sand.
    - Raking joints and repointing.
    - Thickness of joints.
    - Tooling joints.
    - Excessive quantity of reveals and broken surfaces?
    - Copings.
    - Flashing blocks.
14. Hollow Tile Work:
    - Trucking.
    - Unloading and piling.
    - Mortar.
    - Mortar tubs.
    - Scaffold plank and horses.
    - Hoisting and distributing.
    - Laying.
    - Smooth tile more expensive to lay than scored.
    - Is backing tile ordinary partition tile or special backing tile?
    - Lintels or wall bearing tile reinforced?
    - Anchors.
    - Mesh reinforcement.
15. Mill-work and finished carpentry.
    - Material.
      - Hauling.
      - Hardware.
      - Weights.
      - Chains.
      - Labor.
      - Unloading.
      - Hoisting and distributing.
      - Setting.
      - Hanging.
      - Fitting and adjusting.
16. Wood Flooring:
    - Sleepers.
    - Cinder concrete fill.
    - Underflooring.
    - Nalecode.
    - Tar and sand base.
    - Anchors.
    - Finish flooring.
      - Quality—Is specification in accordance with standard specifications?
      - Quantity—Allowance for dressing and waste.
      - Nails and method of nailing.
      - Building paper.
      - Scraping.
      - Sanding.
      - Oiling.
      - Protection.
17. Rough Carpentry:
    - Framing.
    - Bucks.
    - Grounds.
    - Furring strips.
    - Carpet strips.
    - Nailing pieces.
    - Centers for mason work.
    - Protection for mason work.
    - Finished lumber not included in sub-bid for mill-work.
18. Metal windows:
    - Hauling, hoisting, and distributing.
    - Erection.
    - Grouting and caulking.
    - Operators.
    - Special mullions.
    - Perry strips.
19. Miscellaneous iron work:
    - Allow for setting pieces not set by sub-contractor.
20. Protection:
    - Over sidewalks.
      - Waterproofing.
      - Electric lighting.
      - Special finish.
    - Around hatchways.
    - Adjacent roofs.
    - Temporary partitions or screens in connection with alterations.
    - Temporary stairs.
    - Carry up adjacent chimneys.
21. Cutting and patching.
    - Concrete.
    - Brick.

- Tile.
- Woodwork.
- For trades not in general contract.

22. Cleaning and removing rubbish:
    - Labor.
    - Truck hire.
    - Dirt chutes.
    - Washing windows.
    - Cleaning for sub-contractors, especially plasterers.
23. Tools and supplies:
    - Ordinarily consumed or heavily depreciated during the life of a job.
24. Plant:
    - Charge for use, depreciation shop repairs.
    - Rental if hired.
    - Materials.
        - Lumber or steel for hoist-towers.
        - Freight and trucking.
        - Lumber for temporary buildings.
        - Lumber for concrete runs.
        - Temporary toilet.
        - Bins.
        - Fuel.
        - Power and water lines.
    - Labor
        - Receiving, installing and dismantling.
        - Building hoist-towers, temporary buildings and runways.
        - Maintenance and job repairs.
25. Insurance:
    - Workmen's compensation.
    - Public liability.
    - Subcontractors liability.
    - Owners contingent liability.
    - Teams and automobile liability.
    - Fire on building, plant and materials including forms.
    - Glass.
    - Temporary elevator.
    - Hold-up and burglary.
    - Armored car service.
26. Winter weather:
    - Materials.
        - Lumber.
        - Canvas.
        - Salamanders.
        - Coke.
        - Rental of boiler.
        - Coal.
        - Lights.
        - Steam pipes.
    - Labor.
        - Placing and removing canvases.
        - Hoisting coke.
        - Tending salamanders.
        - Tending boilers.
        - Shoveling snow.
        - Loss of time of straight time men.
        - Loss of efficiency.
        - Temporary heat for sub-contractors.
27. Job staff:
    - General Superintendent.
    - Superintendent.
    - Assistant Superintendent.
    - Engineer.
    - Accountant.
    - Timekeeper.
    - Material clerks.
    - Tool house attendant.
    - Watchman.
    - Stenographer.
    - Office boy.
    - Water boys.
    - Owner's inspector or City inspector.
28. General Expenses:
    - Materials.
        - Rental of working space.
        - Trucking from working space to job.
        - Traveling and transportation expenses including special conveyances.
        - Board.
        - Office supplies and stationery.
        - Postage and Telegrams.
        - Telephone.
        - Photographs.
        - Permits, including vault permit.
        - Tests.
            - Soil.
            - Floors.
            - Piles.
        - Royalties.
        - Repair sidewalks, curbs, and pavement.
        - Premiums on surety, guarantee and maintenance bonds.
    - Labor.
        - Traveling time.
        - Idle time of straight time men (except on account of winter weather)
        - Remedying errors.
        - Making good damage due to accidents.
29. Main office expenses:
    - General executive expense.
        - Advertising.
        - Estimating.
        - Selling.
        - Purchasing.
        - Direction.
        - Accounting.
        - Engineers and draughtsmen.
        - Blueprints.
        - Stationery.
        - Postage.
        - Telegrams.
        - Telephone.
        - Interest on money used.
30. Subcontracts:

These will not be discussed individually. In general the important points to be considered in selecting subcontract figures are as follows:

1. Is the sub-bid in question a straight unconditional offer to perform a definite part of the work for a definite sum of money?
2. Is it conditional on present wage rates?
3. Does it appear to be too low? If so, the subcontractor should be given an opportunity to withdraw it, with the understanding that he will so notify all other general contractors whom he has quoted.
4. Can the sub-contractor furnish the quality of work required.
5. Can he perform the work with the necessary speed?
6. If the specifications call for a certain article by name "or equal", will a substitute be accepted?
7. Work to be done by the general contractor in connection with subcontracts.
    - Hoisting.
    - Scaffolding.
    - Mortar.
    - Protection.
    - Anchors.

31. General:

In addition to the usual study of specifications with the idea of determining what clauses should be taken exception to in proposal letters, special thought should always be given to the following points which may involve the contractor in serious obligations:

1. Foundation conditions.
    - a. Responsibility for bearing value of soil.
    - b. Responsibility for distance down at which good bearing will be found.
2. Waterproofing.
    - a. Adequacy of specification.
    - b. Nature of guarantees.
3. Financial responsibility of owner and terms of payment.
4. Responsibility for shrinkage and settlement, and nature of guarantees if any.
5. Responsibility for complying with laws and ordinances.
6. Time of completion—penalties.
7. Camp and commissary.
8. Reputation of architect, engineer and owner for fair dealing.

32. General Contingency.

33. Profit.

Mixing by Hand

A Letter from Philip Weiss

PHILADELPHIA, PA.

It is one of my maxims—"Do not make a virtue of necessity, but make an experiment of it."

As a small jobbing contractor I mix some concrete by hand. Now mixing concrete by hand is an obsolete art. However, there are occasions even on the biggest jobs when some concrete has to be mixed by hand. Therefore it may interest some of your readers to know how I mix concrete. I want to say at the start that my work stands up on the average much better than the jobs turned out by the better class of contractors using mixers. People are prone to judge by analogy. Because a machine made product is uniform therefore concrete mixed by a mechanical mixer is more uniform than hand mixed concrete. That is true to a certain extent on big jobs but on small jobs the facts do not bear out this theory.

When I say facts I do not refer to fly-by-night or ignorant contractors deliberately skimping the concrete: I refer to concrete as turned out by the average small mixer when given the average attention prevailing on the average small job. Let me illustrate that. I put in last year a coping 150 ft. long, 6 in. wide, 6 in. high, in the back and 4 in. in the front, without expansion joints. The other day I passed by and looked it over carefully and I found one tiny crack. Remember, this is an average job. Now I want to demonstrate why the same job put in with machine mixed concrete would in all probability have shown many more cracks.

A half bag mixer holds three small wheelbarrows of concrete, or let us say two wheelbarrows; the first wheelbarrow gets most of the coarse aggregate; this is particularly true when you use slag, as slag is lighter than sand and cement. This *inherent* defect of the mixer is of not so much importance on a job where you can dump two or three wheel barrows on the same place, as the raking or spading will even up the concrete to a certain extent, but in a small coping there is no chance for that, and the coping is bound to be more or less porous where the first wheelbarrows were dumped.

However, I started out to say how I mix concrete by hand. I train my laborers to spread out the sand evenly and as thin as possible in an oblong rectangular form. Then comes the cement spread out evenly on top; then two men turn it over with shovels while one man rakes it. I am particular about the raking and I always put the best man on the rake. I want to emphasize this last sentence because if left to themselves it is always the laziest man who gets hold of the rake. If the sand is dry one turning is enough, but if the sand is damp it may require two or three turnings. After a few days training my men take a pride in it, not finding a single streak of sand after turning over twice. Then we spread it out the same as before and put the stone on top uniformly thick. After that we wet the whole pile. The wetting must be done slowly and uniformly, so as to give the water a chance to soak into the cement underneath. If you put on the water too fast part of it will run away and wash some cement with it. Usually I start another batch while the first batch soaks. You have to use your own judgment on the amount of water, as different jobs require different consistencies. I do not consider a laborer well broken in until he is able to mix a batch without losing a drop of water, which is some trick, particularly if you mix on a very steep street. Next we turn the whole batch over once, the same as before, two men shoveling and one man raking. If the men with the shovels are too ambitious I have to slow them down to give the man with the rake a change to do a good job.

Rapid Hardening Slag Cement

By Pierre Prevost

ENGINEER, PARIS, FRANCE

The necessity of executing certain jobs with rapidity, and particularly street surfacing in large cities, has attracted attention to the advantages obtained from the rapid hardening of cements.

The following is a technical study to which we are adding some information on the results obtained with rapid hardening slag cement as manufactured in France, at Vitry-le-Francois, in the factory operated by Societe Generale des Chaux et Ciments.

RAW MATERIALS

This cement is prepared by a mixture of lime and sand slag. The slag enters into the manufacture in the proportion of 80% and lime is used to correct the chemical composition of slags the contents of which in silicates and aluminates, the constitutive elements of cements, are variable according to the operation of the blast furnaces and the ores used.

In view of the fact that slag from blast furnaces represents a considerable volume and weight (one ton of castings gives nearly one ton of slag), it constitutes an inexhaustible raw material and one of very modest net price.

COMPOSITION

Rapid hardening slag cement is characterized by its aluminous and silicious composition: we are giving hereafter the figures of a medium analysis which figures can be compared with those of the artificial portland.

	Rapid Hardening Slag Cement	Artificial Portland
Combined Silica	24.2	21.0
Silicious Sand	1.2	0.5
Alumina	13.8	7.0
Iron Peroxide	1.6	3.0
Lime	46.3	64.0
Magnesia	2.4	0.8
Sulfuric Acid	0.9	0.9
Undosed Substances	9.6	2.8
	100.0	100.0

DURATION OF SETTING

The rapid hardening slag cement begins setting only about four hours after mixing; it terminates setting thoroughly some 8 to 12 hours afterwards.

The rapid hardening permits of having high degrees of resistance after 24 hours which increase very rapidly until seven days following, and still continue increasing regularly, especially in mortars.

NEAT CEMENT

	24 Hrs.	2 Days	7 Days	28 Days	3 Mos.
Rapid Hardening Slag Cement (Louve Make)	17	24	29.7	32	36.5
Slag Cement responding to the Charge Book of Paris City		7	20	26	28

1:3 MORTAR

	24 Hrs.	2 Days	7 Days	28 Days	3 Mos.
Rapid Hardening Slag Cement (Louve Make)	13	18.6	27.5	31.3	35
Slag Cement responding to the specifications of Paris City		6	16	25	29
Artificial Portland responding to the specifications of Paris City		10	18	22	26

The above tables show with sufficient evidence the exceptional qualities of this cement.

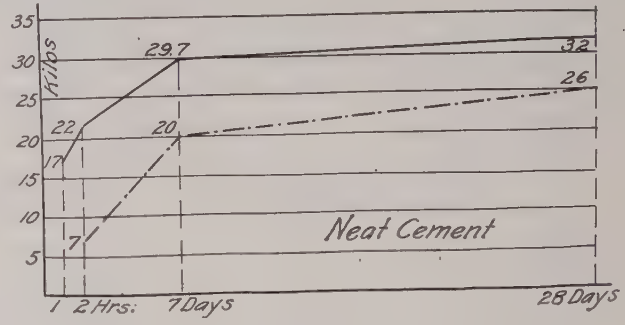


FIG. 1

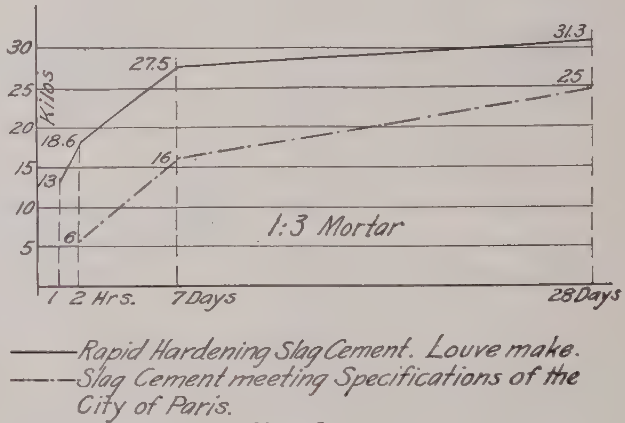


FIG. 2

Fig. 1—Graph showing tensile strength of specimens of neat rapid hardening slag cement compared with slag cement meeting specifications of City of Paris

Fig. 2—Comparative tensile strengths of 1:3 mortar specimens

RESISTANCES TO COMPRESSION

Upon request of the engineers of the City of Paris, compression tests were made at the Municipal Laboratory of the City of Paris upon the rapid hardening slag cement, with a view to comparing these resistances to those of the Municipal slag cement and of the artificial portland cements.

The results of those tests were communicated to us and we are giving them below; the cubes used had 20-cm. sides. Resistances are expressed in kg. per sq. cm.

1st.—Composition of the Concrete.. { 150 Kgs. cement;
1 cu. M. pebbles 20 to 40 mm.
½ cu. M. sand.

	18 Hrs.	24 Hrs.	48 Hrs.	7 Days
Rapid Hardening Slag Cement, Louve Make	3	9.2	18.5	27.5
Slag Cement V. P. (City of Paris), standard quality		2.7	4.2	21.9
Artificial Portland (City of Paris)			9.0	21

2nd.—Composition of the Concrete. { 350 Kgs. cement;
1 Cu. M. small gravel 5 to 20 mm.
½ Cu. M. sand.

	18 Hrs.	24 Hrs.	48 Hrs.	7 Days
Rapid Hardening Slag Cement, Louve Make	7.9	9.7	18.8	38
Slag Cement, City of Paris, standard quality	3.2	4.2	6.2	25

Directions for Use

Rapid hardening slag cement is treated, in the mixing, just like artificial portland; its use does not offer any special difficulty.

Applications made in 1923 and 1924 served to determine the most favorable composition for the mixing of mortars and concretes.

Kinds of Mortars and Concretes:	Uses and Applications	Gravel in cu. m.	Sand in cu. m.	Cement in Kgr.	Volume Obtained
Sand Mortar	Sealing, Grouting		0.600	500	
Very rich Concrete	Moulding, Agglomerate Pipes	0.600	0.600	500	1 cu. m.
Rich concrete	Foundations under water, Bridge Piers	0.850	0.425	350	1 cu. m.
Ordinary Concrete	Canal Floors Vaults Sewers	0.900	0.450	250	1 cu .m.
Poor Concrete	Foundations	1.000	0.375	175	1 cu. m.

Uses of Rapid Hardening Slag Cement

The Societe Generale des Chaux et Ciments has considered its use in all cases where it is important to obtain, in a very short time (2 days), the same resistances that are obtained by other products only after a week.

This purpose was obtained. We may particularly mention the fact that the foundations of paving made with this cement on the Grand Boulevards in Paris, could be released for traffic four days after the concrete was placed.

This cement showed particularly effective in all foundation work; a considerable volume of this cement was used in the construction of walks along street railways during the years 1923 and 1924.

Large railroad companies have used this cement for quite a number of different purposes.

This cement has permitted of making clinker brick which, after steam curing, reach a considerable hardness, surpassing that obtained with the ordinary silico-calcareous products.

Particularly, the Society for the Industrial Treatment of the Urban Residues of the City of Paris was able to utilize clinkers from night-soil, with a percentage of rapid hardening slag cement that does not exceed 6% of the quantity of clinkers.

All such results are very interesting, so much more as the cost of rapid hardening slag cement does not exceed the cost of artificial portland of standard quality.

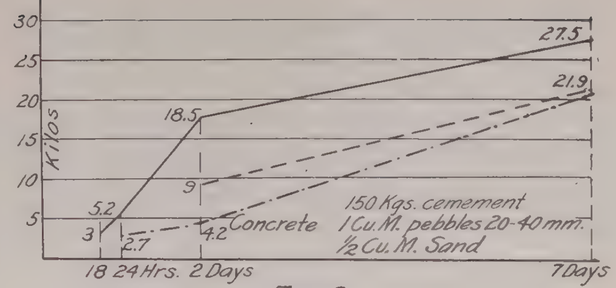


FIG. 3

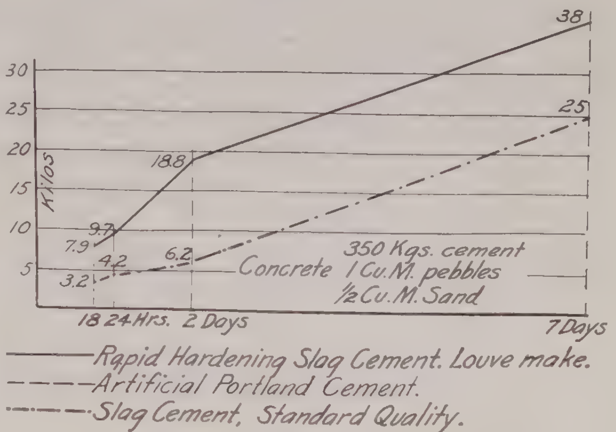


FIG. 4

Fig. 3—Graph showing comparative compressive strengths of concretes made with rapid hardening slag cement, Louve make, with artificial portland cement and with slag cement of standard quality

Fig. 4—Comparative compressive strengths of rapid hardening slag cement concrete and concrete of standard quality slag cement

Its application to resurfacing of roads has a great future, and the tests already effected on various French roads, after the principle of consolidation of the road macadam, as explained below, have given the best results.

Consolidation of the Road Macadam

Present macadam roads are formed by materials that are not perfectly bonded together. To bind the macadam stones

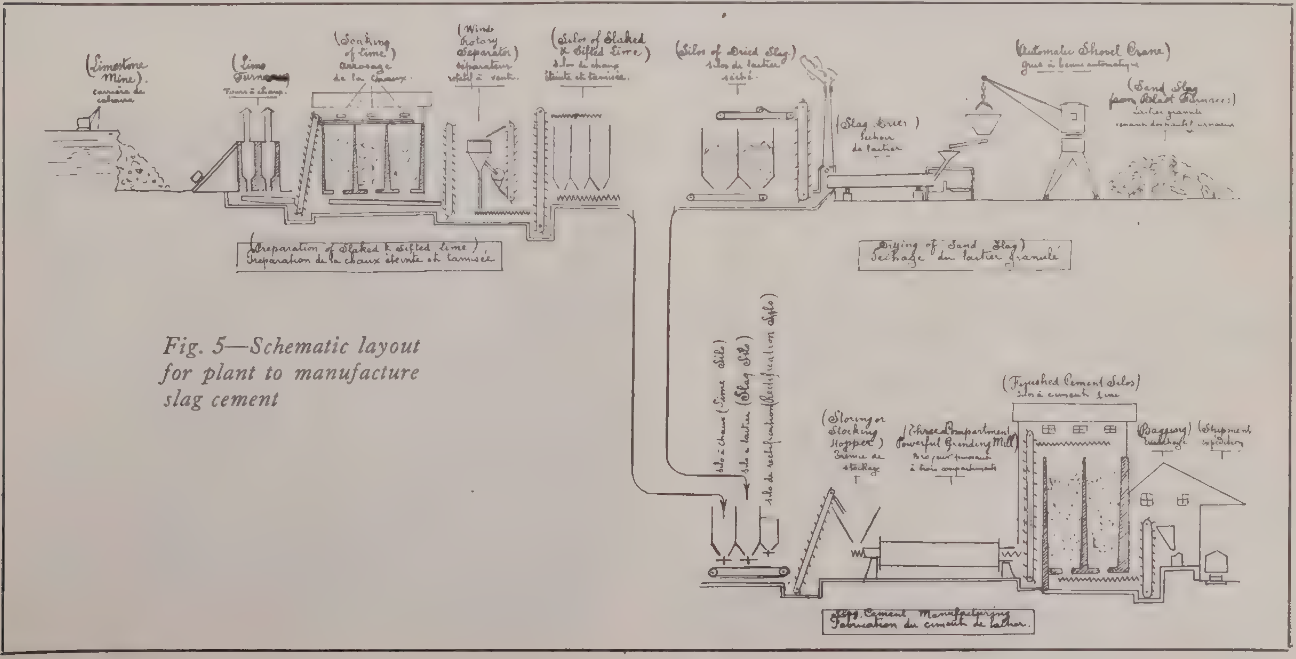

(Limestone Mine).
carrière de calcaire
(Lime Furnace)
Fours à chaux.
(Soaking of Lime)
arrosage de la chaux.
(Wind Rotary Separator)
séparateur rotatif à vent.
(Silos of Slaked & Sifted Lime)
silos de chaux éteinte et tamisée.
(Preparation of Slaked & Sifted Lime),
Preparation de la chaux éteinte et tamisée
(Silos of Dried Slag.)
silos de laitier séché.
(Slag Drier)
Sechoir de laitier
(Automatic Shovel Crane)
grue à benne automatique
(Sand Slag from Blast Furnaces)
laitier granulé
(Drying of Sand Slag)
Séchage du laitier granulé
silo à chaux (Lime Silo)
silo à laitier (Slag Silo)
silo de rectification (Rectification Silo)
(Storing or Stocking Hopper)
Trémie de stockage
(Three Compartment Powerful Grinding Mill)
Broyeur puissant à trois compartiments
(Finished Cement Silos)
silos à ciment fini
(Bagging)
Ensachage
(Shipment)
expédition
Slag Cement Manufacturing
Fabrication du ciment de laitier.

Fig. 5—Schematic layout for plant to manufacture slag cement

together a mixture of sand and limestone is used that does not offer any resistance. This binder is changed to dust and mud, and is destroyed in a short time.

Following the disappearance of the binding matter, the macadam stones are dislocated and the destruction of the road follows rapidly.

The above binder, made out of sand and limestone, is replaced by a mixture of sand and rapid hardening slag cement as per the following proportion:

Sand (grains 1 to 5 mm.), 1 cu. m.
Rapid hardening slag cement, 250 to 400 kgs.

The mixing is done with dry materials on a plank floor or in a mixing machine; one cu. m. of cement and fine aggregate is used to 7 cu. m. of broken stone.

This mixture is used as follows:

After the stones have been rolled down with a dry steamroller, the dry mixture is spread in 4 different layers, and after each spreading the roller is passed twice. The quantity of the mixture is known to be sufficient when the mixture of slag and sand fills ¾ of the thickness of the stone layer.

Then the rapid soaking is done by a moderate sprinkling with a street sprinkler, compressing immediately with the heavy roller 8 or 10 times.

On account of the slowness of the rapid hardening slag cement (8 to 12 hours, according to temperature) it gives all the necessary time to effect this last rolling before the mortar begins to harden.

The use of cement causes an increase, in the net price, of 2 francs per square meter as compared with macadam. This is very slight as compared with the results obtained by this process, both in the duration and in the maintenance of roads.

MANUFACTURE AND NET PRICE OF RAPID HARDENING SLAG CEMENT

The slag is dried and the hydrated lime is sifted as indicated for the manufacture of the ordinary slag cement.

The materials thus prepared pass through different additions and then are finely ground, following a special method which is covered by a patent.

The equipment necessary for the manufacture is of the type generally used in the cement industry.

The net price is particularly interesting if we consider the quality of the product obtained which, in France and Belgium, is sold for the same basic price as the artificial portland.

The net price, to factories installed within a few miles around blast furnaces, where they are able to obtain the slag under excellent conditions, as also the power, may be around 50 to 55% of the price of the artificial portland cement of the most satisfactorily located firms.

The difference between the net price and the sale price shows the extent of the value of this manufacture and the interest it can have in store for metallurgical countries where slag is produced on a large scale, if attention is given to the development of cements based on slag, such as the rapid hardening slag cement.

Freezing and Thawing Tests of Cinder Concrete Tile

Columbia University Testing Laboratories, New York City, reports freezing and thawing tests of Cinder concrete tile from the Cinder Tile Co., 120 West 42nd St., New York City. (Report No. 1448, Dec. 2, 1924). The laboratory reports:

The material submitted and tested consisted of one 8x8x16 cinder concrete tile; one 8x12x16 cinder concrete tile; one 8x8x16 semi-solid cinder concrete tile, taken from a lot selected and marked by the Bureau of Buildings, City of New York, represented by Mr. Heatley, Borough of Bronx. The remainder of this lot had previously been tested on September 23, 1924, in the presence of representatives of the Bureau of Buildings, City of New York. All material mentioned was submitted by the Cinder Tile Co., 120 West 42nd Street, New York City, represented by E. B. Corbet.

The three specimens were dried to constant weight and immersed in water. Four hours later they were placed in a refrigerator maintained at a temperature of 6° F. and allowed to remain for 23 hours. They were then removed and placed for one hour in water having a temperature of 150° F. At the end of this thawing period, the specimens were again placed in the refrigerator and frozen as above and again thawed, thus causing the tile to be alternately frozen and thawed once every twenty-four hours. The test consisted of twenty such alternate freezings and thawings. At the end of this freezing test, the specimens were again dried to constant weight and the compressive strength determined. The following tables give the results of the freezing and thawing tests:

TABLE 1—LOSS OF WEIGHT

Specimen	8x12x16 Tile	8x8x16 Tile	8x8x16 Semi-Solid Tile
Original Wt.—lbs.	53.3	36.3	47.3
Weight after Freezing	51.6	36.3	47.3
% Loss	3.8	0	0

TABLE II—COMPRESSIVE STRENGTH AFTER FREEZING

Lab. Test No.	28549	28550	28551
Spec.	8x12x16	8x8x16 semi-solid	8x8x16
Length, in.	16.00	15.85	15.90
Width, in.	12.10	8.06	8.05
Height, in.	8.05	8.35	8.50
Area, sq. in.	193.5	127.9	128.0
Max. load, lbs.	294700	102700	143850
Ult. Str. lbs., sq. in. after freezing	1529	804	1123
Compressive Str., lbs. sq. in*	1152	948	915
% Change in Str.	32.6 gain	15.2 loss	22.7 gain

*Note—These values obtained from Lb. tests 27517-19, 27538-40, 27524-26 of September 23rd, 1924.

Classification of Products Costs

Requests from members of the Wisconsin Concrete Products Association for a Classification of Accounts impelled D. R. Collins, secretary-treasurer, to send out the list which follows for classification and checking over against the members' own costs.

PLANT EXPENSE
- Superintendence
- Plant Labor
- Other Labor
- Gas, Oil and Grease
- Power and Light
- Freight Incoming
- Fuel
- Repairs—Machinery and Equipment
- Repairs—Bins and Conveyors
- Repairs—Buildings
- Other Misc. Plant Expense
- Depreciation—Building
- Depreciation—Machinery
- Depreciation—Small Tools and Equipment
- Depreciation—Gravel Bins and Equipment

SELLING EXPENSE
- Salesmen Salaries
- Salesmen Expense
- Advertising

DELIVERING
- Wages—Truck Drivers and Helpers
- Freight Paid out-of-Town Orders
- Gas, Oil and Grease
- Repairs—Truck
- Misc. Delivering Expense
- Depreciation Delivery Equipment

ADMINISTRATION EXPENSE
- Officers or Proprietor Salaries
- Office Help
- Office Expense

GENERAL
- Taxes Paid
- Interest Paid
- Insurance Paid
- Other General Expense

Wilkes-Barre Plant Makes Block, Brick and Tile

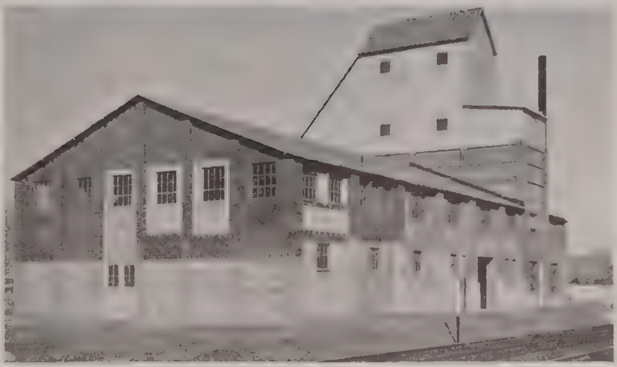


Fig. 1—The Schott plant, in whose construction Straub cinder block, Blystone tile and Shope brick were used

F. L. Schott, Wilkes-Barre, Pa., decided to engage in the manufacture of concrete products only after he had made a most thorough investigation of many phases of the industry in numerous localities.

As a result of his studies he has decided that he could base his fortunes on no one unit, but that to engage in a well rounded building materials business it was necessary for him to manufacture a variety of units, some one or two of which would inevitably find their way into almost any structure which might be built in his vicinity.

He selected as a back-up material Straub cinder concrete block. As an alternate back-up material which might serve for garages and small industrial buildings and for a face material as well, he selected Blystone dry wall tile. One reason for the selection of this unit was the practicability with which it may be colored. As a strictly face material he selected Shope brick.

To date, rather than push vigorously the manufacture and sale of any one of these units he has adopted the policy of securing as many examples of the use of each of these units as is possible. Accordingly, he has now in Wilkes-Barre and vicinity one or two schools faced with Shope brick; several residences built of cinder block and faced with stucco; and a large number of small garages and a few industrial buildings constructed of Blystone tile. By this policy Mr. Schott believes that he is building for himself a reputation for manufacturing building materials which are available for any type of project.

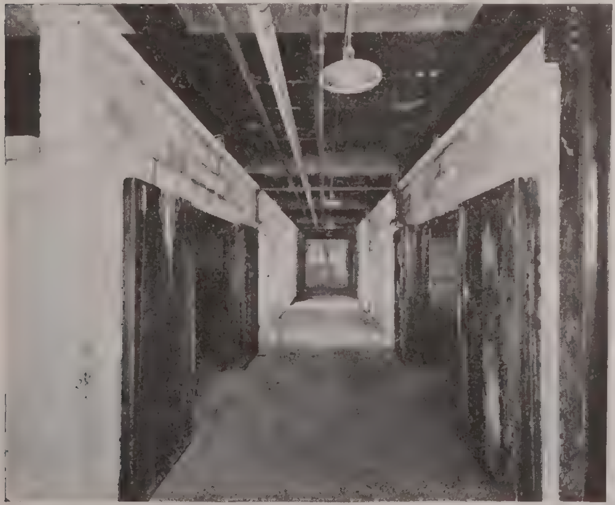


Fig. 2—Steam curing rooms on either side of a wide center aisle

THE PLANT

Believing that a well-built structure to house his manufacturing operations would more than pay for itself in advertising, Mr. Schott has erected a plant building which has concrete masonry walls, concrete foundations, heavy structural steel framework and concrete floors for both first and second stories. The plant is an outstanding example in itself of concrete masonry construction. Use was made in building the walls of all the products manufactured. The plant is shown in Fig. 1 and views in Figs. 2, 3, and 4. The layout is diagramed in plan and section in Figs. 5 and 6.

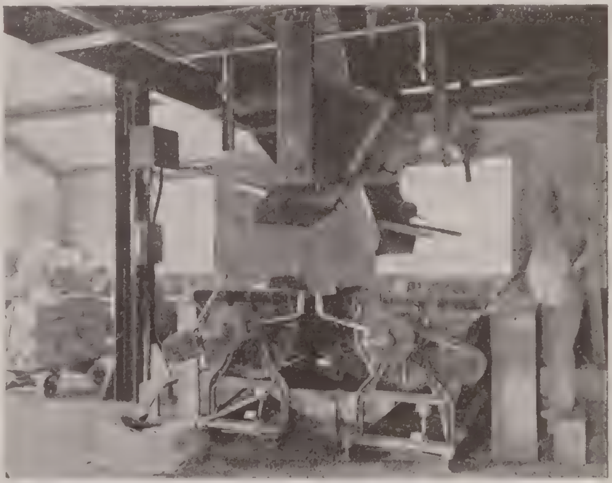


Fig. 3—Shows about half the mixer room and two Blystone mixers

In line with various other investigations carried on by products manufacturers, Mr. Schott has taken pains to learn the proper proportioning of aggregates to secure efficient results from the use of cement. Inasmuch as none of the gravel aggregate nor cinder aggregate as it comes from the crusher is graded, for best commercial use, Mr. Schott decided to separate his materials, both sand and cinders, into coarse particles and fine particles, and then blend them according to predetermined proportions by the use of adjustable measuring boxes. This in itself is an outstanding feature in products manufacture in Mr. Schott's district.

With special reference to cinders it was noticed that the ordinary run-of-crusher cinders were not uniform with respect to grading. Samples taken from the same bin from day to day varied greatly in grading, as also did samples taken from the same bin and from the same cinders from hour to hour.

Recognizing that strength of the products is in a measure governed by grading of the aggregate for any mix, Mr. Schott

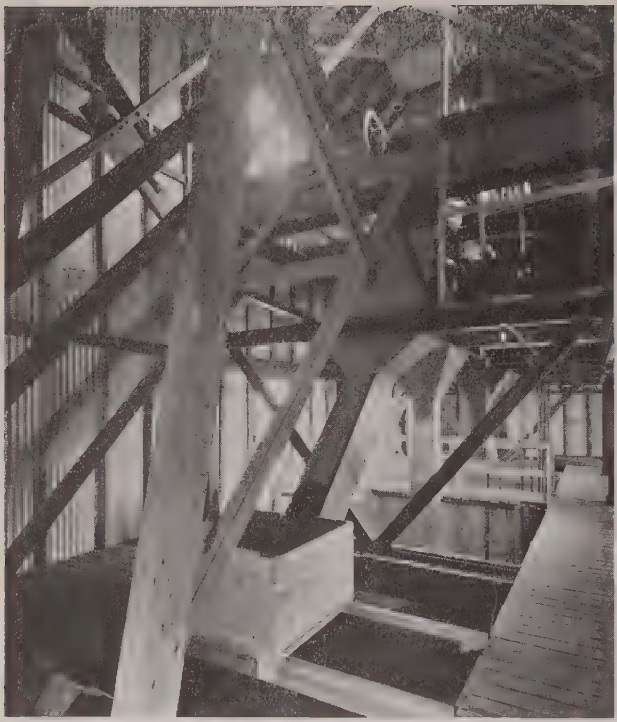


Fig. 4—Enclosure over bins containing crusher, screens and chutes

decided that uniform grading would tend to produce a uniformity in strength. He, therefore, separates the cinders into fine and coarse and then blends these grades together to produce the grading which by a short series of tests he has found would give him a satisfactory block. The cinders in fine bin have all passed a screen with 3/8-in. openings. The cinders in the coarse bin are all retained on a 3/8-in. screen and all particles greater than 3/4 in. have been thrown out. The percentages of fine and coarse are 40% and 60%. Mr. Schott recognizes that other gradings may be worked out which theoretically would produce a better product.

A study of the cross-section of the plant (Fig. 6) indicates the following set of operations: a car of aggregate is supported over the track hopper; the skip-hoist, automatically operated, carries the material to receiving hopper equipped with a two-way boot which discharges onto an endless chain. If the aggregate be cinders, the chain carries the aggregate through a crusher over a set of screens which separate the material into coarse and fine and which discharge through two chutes into the coarse bin and the fine cinder bin. If the material be gravel, the chain carries the aggregate directly to a set of screens where it is separated and discharged into the fine sand bin and the coarse sand bin.

An adjustable measuring box by means of a movable center partition is swung beneath the bins and over the mixers and the proper charge of blended aggregate is delivered to each mixer. In the case of cinders the mixer discharges directly into a chute with a gate at the first floor level. Here concrete buggies are used to convey the mixed cinder concrete to Multiplex block machines in or near the steam rooms. (As in most cinder block plants the machines are on skids and are moved away from the racks as they are filled.) In the case of the gravel aggregate, the mixer discharges the mixed gravel concrete into two chutes, one of which conducts it to the Blystone tile machine where Blystone tile are made and conveyed to steam rooms on rubber tired trucks. The other chute discharges into a monorail bucket which supplies a series of Shope brick machines. Shope brick are made and conveyed to steam rooms on rubber tired trucks.

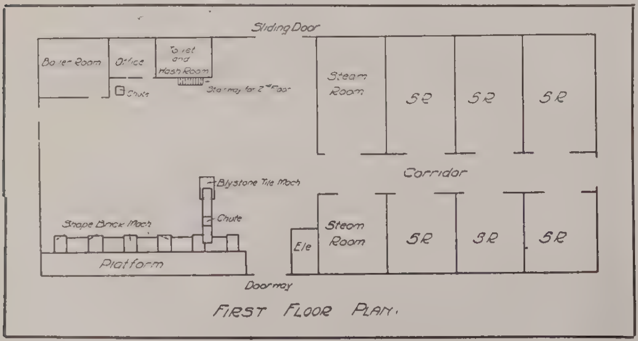


Fig. 5—How the plant looks in plan

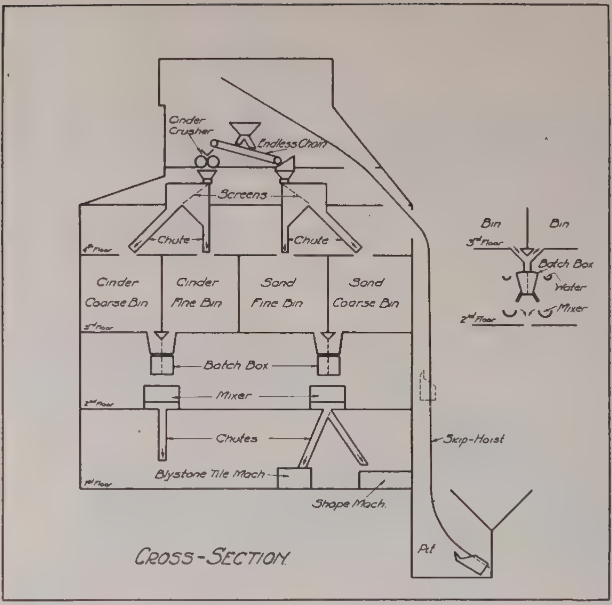


Fig. 6—A sectional elevation of Schott plant showing features of operation

The capacity of products for this plant may be estimated at 30,000 Shope brick per day; 4,800 cinder block per day; and 3,600 Blystone tile.

The plant is constructed with four steam rooms on each side of the main aisle. The rooms on one side of the aisle are built to hold 1,500 block, 10,000 brick, or 20,000 tile. Each room in the smaller set will hold 1,000 block, 7,000 brick or 1,250 tile. The steam room layout was decided upon after the following reasoning: the Shope brick undoubtedly require steam curing; the Blystone tile are also more economically made when steam rooms are available. This class of unit is usually made on a machine which is stationary, and they must be transported from the machine to the curing room. The usual layout for such a proposition consists of long and narrow steam rooms, each holding a day's work, and equipped with cars and tracks, or floored with a smooth concrete floor to permit the use of lift trucks. In this plant, however, cinder block are manufactured on Multiplex block machines. Economy here dictates that the machines be movable and the finished block stationary. As steam curing is required for these products, it is advisable to set up the block machines in or adjacent to

Fig. 7—Garage, boiler house and paint shop built of Schott red dry wall tile

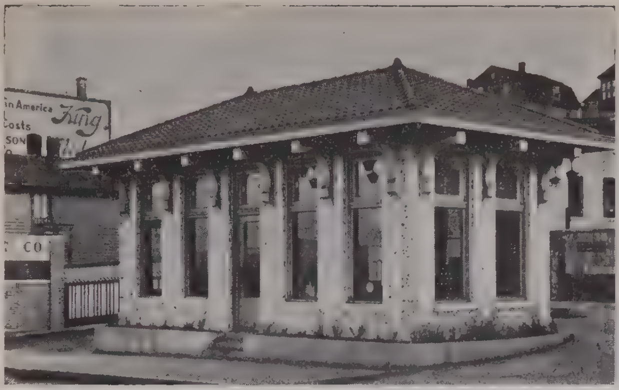


Fig. 8—Gasoline station built of Shope brick

the steam rooms so that a minimum of transportation is required to place the finished block where it belongs. Accordingly the steam rooms in this plant were laid out with this idea in mind. Each room is large enough to accomodate a Multiplex block machine, together with the crew necessary for its operation. At the same time these rooms of course can be used to accomodate the products from the Shope brick machines and the Blystone tile machine, which are transported to the steam rooms on rubber tired trucks.

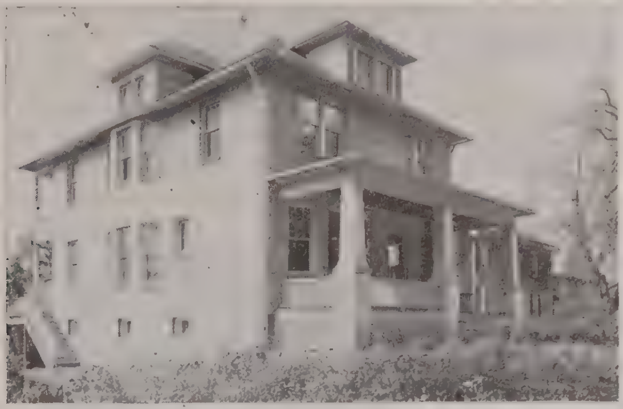


Fig. 9—Schott's Straub cinder block used in walls of this house in Wilkes-Barre

Based on mixer capacity, that is, a continuous operation of four Blystone mixers, each of the machines can be operated at full capacity. However, based on steam room capacity, and all winter operation is of necessity so figured, maximum capacity is as follows: All five brick machines may be operated, or three Multiplex block machines, or one tile machine and one block machine, or one block machine and three brick machines. The number of men required of course varies with the number of machines in operation. However, twelve men together with a foreman and mechanic can very probably take care of the maximum production.

The Kingston, Pa., school in which Schott products were used extensively was shown in CONCRETE for April. Other classes of Schott product structures are here illustrated. The Schott products plant has recently been taken over by the Nepenna Building Materials Co., a Pennsylvania corporation, with Mr. Schott as president. The plant opened the season with a stock of 100 thousand block and one million brick.

If you have worked out a good idea, pass it on. Tell it to the other fellow, as others have in this issue.

Long Time Tests of Unsound Cement

Early in 1919 considerable interest was manifested in certain cement which had failed to meet the soundness test called for in the specifications. The usual cement tests were carried out on it by the Bureau of Standards and concrete cylinders were also prepared for various conditions of storage. Some additional briquettes were made for long-time observation and test. As a matter of interest, parallel tests were made from another lot of cement of a different brand which complied with the requirements for soundness. The results of the tests, which now include those made after six years storage under different conditions, are as follows:

COMPRESSIVE STRENGTH OF 1:½:3 CONCRETE (LB. SQ. IN.)

Cement	Age	Storage		
		Moist Air	28 Day Moist Air Thereafter Laboratory Air	28 Day Moist Air Thereafter Outside Air
Unsound..	7 day	1700		
	28 day	2090		
	3 mo.		2810	2800
	1 yr.		3440	3270
	2 yr.		2940	2740
	6 yr.		3180	4400
Sound.....	7 day	1440		
	28 day	2270		
	3 mo.		3060	2440
	1 yr.		2960	3090
	2 yr.		2310	3000
	6 yr.		No specimens	4780

TENSILE STRENGTH OF 1:3 STD. SAND BRIQUETTES (LB. SQ. IN.)

Age	Unsound Cement		Sound Cement	
	Water Storage	Lab. Air Storage	Water Storage	Lab. Air Storage
7 days	235		293	
28 days	342		422	
6 years	321	131	388	446

CONDITION OF SPECIMENS

Examination of the specimens at the 6-year test period resulted in the following observations:

The unsound cement specimens which had been stored indoors showed no apparent peculiarity.

The unsound and two of the sound cement concrete specimens stored under outdoor conditions had developed cracks, mostly of a circumferential nature. Some of these cracks, as judged by the appearance of the interior of the specimen after test, had extended to a depth of several inches. The cracking appeared more pronounced for the unsound than for the sound cement.

The briquettes in water storage did not show any signs of disintegration. The briquettes made from the sound cement and stored in the laboratory air appeared free from disintegration. Those in similar storage, but made from the unsound cement, were badly disintegrated. The outer portions could readily be broken off by the fingers to a depth of about ¼ in. This behavior has been noted in similar tests of other unsound cement.

Remarks.—No conclusions are drawn either as to the cause or effect of unsoundness, but a question is presented and some facts have been noted which are of interest in the testing of cement and concrete.

(1) Is the tendency of an unsound cement mortar briquette to disintegrate, when in dry air storage, also present in concrete, only to a lessened degree?

(2) The tensile specimens in water storage show the retrogression not uncommon in similar long time tests. The air storage specimens for the sound cement show an increase in strength over the specification 28-day test, while those of the unsound cement show a great decrease. In neither case does the tensile strength behavior bear any constant ratio to the concrete strength.

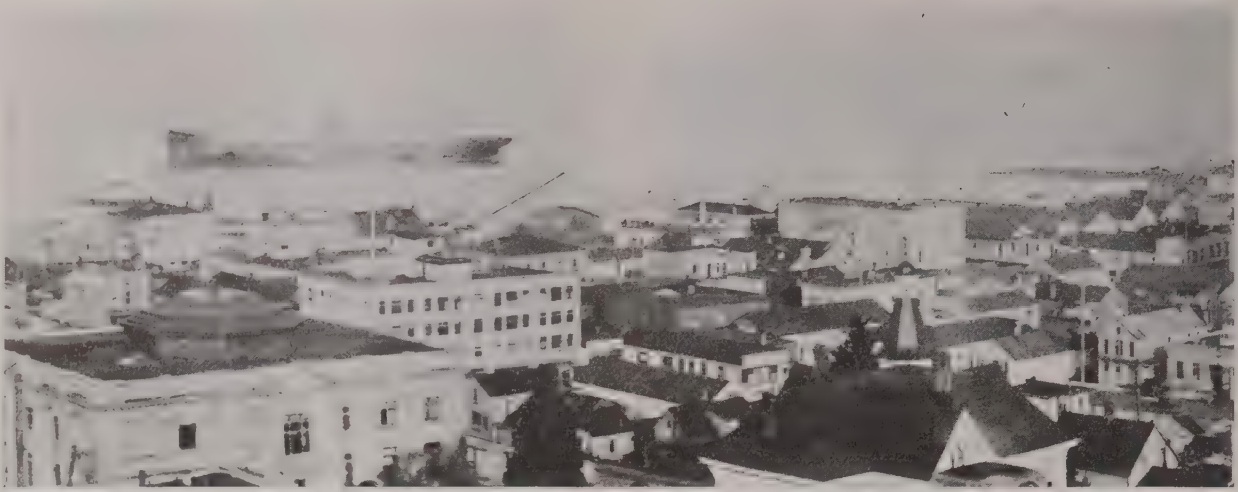


Fig. 1—Astoria, Oregon, before the fire

Concrete Used Extensively in Rebuilding Astoria, Oregon

"From Ashes to Concrete" was the slogan that gave faith and courage to the people of Astoria, Oregon, to rebuild their city, when on December 8, 1922, a devastating fire burned the entire business area and a part of the residential section. Before the fire, Astoria was an average progressive American city of about 16,000 population. Like the average American

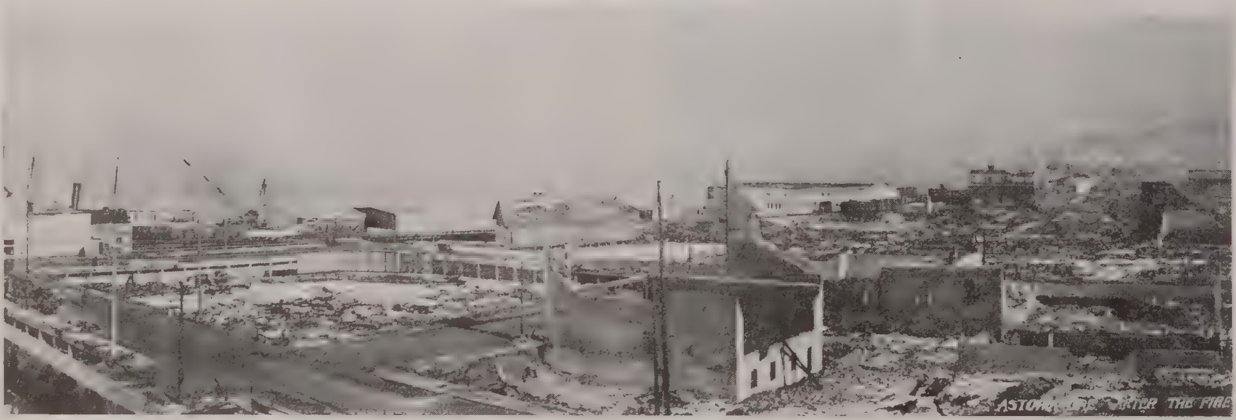


Fig. 2—Astoria, Oregon, three days after the fire

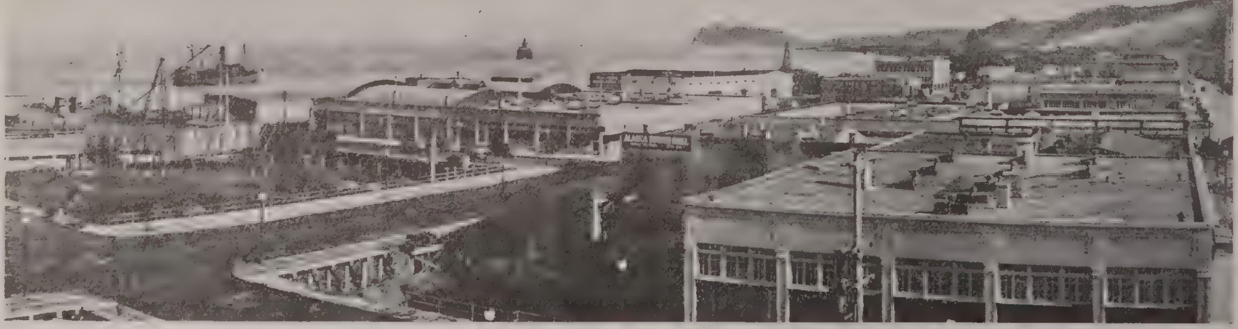
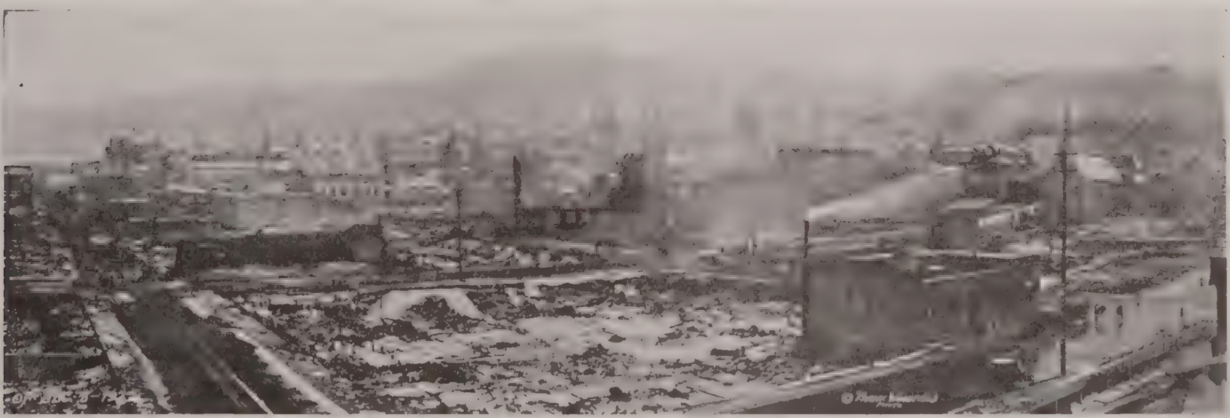


Fig. 3—Astoria, Oregon, reconstructed two years later

city, its business section was composed largely of buildings having exteriors of masonry or concrete and interiors of combustible materials. A considerable number of the buildings were elevated above the natural ground, open spaces being left under them. Some of the streets likewise were supported on heavy timbered construction and had large open spaces beneath them. This condition, functioning like a flue in a large furnace, facilitated the spread of the fire and in some instances allowed the flames to break out a block ahead of the place where the fire fighters were working. What happened to Astoria has happened to a number of other American cities, towns and villages from the largest to the smallest, and it may happen again where fireproof structures do not predominate.

The founding of Astoria dates back to 1811, when the original John Jacob Astor established a fur trading settlement on the south bank of the Columbia River nine miles from its mouth. At the beginning of the war of 1812 it was seized by the English, but later, by the treaty of Ghent, it reverted to the United States. Because of its strategic location, it grew as a shipping center and in its early days much trade was carried on with the Orient. At the present time its salmon



fishing and canning industries are among the greatest in the world.

The recent fire left Astoria without homes, without business, and in ruins. The almost impossible task of rebuilding confronted her; but she shouldered the job and went to work. The illustrations from panoramic photographs tell a remarkable story.

Astoria now, a little more than two years later, is a reconstructed city with buildings of a type far superior to those of the average American municipality, regardless of size. Located in the heart of the lumber producing region, and contrary to the usual natural tendencies, Astoria has erected practically all of her new buildings of some form of concrete construction, either monolithic concrete or concrete block. Walls and partitions in the new structures stand as a barrier against the spread of fire in the contents. Flames cannot make much progress in such construction. A fireproof building standing in the midst of a number of combustible structures may be seriously damaged by intense heat from fires in adjoining buildings. However, when all the construction in a business district is fireproof the danger of a conflagration is eliminated. Because of this improved physical condition, the city's municipal bonds are now selling above par, whereas in the old days they were always heavily discounted.

The story of the reconstruction of Astoria may best be told in the words of an editorial entitled "Two Years Ago," taken from the December 7, 1924 issue, of the *Morning Astorian.* The text follows:

Two Years Ago

When the great fire occurred in Astoria, there probably wasn't anyone willing to hazard the belief that the burned area would be reconstructed within two years. There were faith and courage aplenty, and unbounded confidence in the future, yet even the most optimistic looked forward to rather a dreary waste of years. There wasn't any money to build, or so it seemed, and at best it looked as if there might be a new alignment of things. Possibly Commercial Street might not be the city's principal thoroughfare. Almost anything seemed possible, while one thing appeared highly probable. There would be buildings on Commercial Street, and on Bond and Duane and Exchange, but they would be far apart and empty spaces between would remain for long as scars and mute witnesses of the ordeal through which the city had passed.

Tomorrow will be the second anniversary of the fire, which occurred on December 8, 1922. Two years ago, or even a year ago, few would have dreamed that Astoria would accomplish what it has. Today it may be said that the burned area is practically and substantially reconstructed, and actually a new city has arisen. "From ashes to concrete" within the short space of two years is probably rather fast work, and the city may well pause now to felicitate itself on what has actually been accomplished.

Not only have great things been done, but whatever was done is of the best. The streets are solid, absolutely solid. All the buildings are of concrete and constructed strictly in accord with the rather stiff requirements of the building code. Astoria is again a going concern in every sense of the word. New buildings, new streets, new stores, new lighting system, new water system, new public utilities. It is actually and truly a new town that we have. We may be pardoned for thinking that it is rather a handsome place, as well as substantially constructed.

It will well be worth the while of any Astorian to stop on any of the downtown streets today or tomorrow and contemplate what is to be seen. Possibly to our people, it will seem almost incredible that all this has been done within the short space of twenty-two months.

In retrospect, we may now recall the terrible anxiety of the hours and days following the fire, and recall the desolation and ruins. Everything seemed gone. Generally speaking, it is probably safe to say that the number who were irreparably hurt or ruined by the fire are comparatively few, and that is one of the brightest aspects of the entire tragical thing. And generally speaking, it may also be said that all, or practically all, of the business men have regained their feet and today stand on solid earth, doing a larger volume of business with a new roof over their heads, than before the fire, and the evidences of prosperity and business activity on every side.

The business people of Astoria have done their part in coming back 100%. Now the general public should do its share by patronizing them 100%. That is the only way to maintain and make Astoria prosper. Anyone that does not do this cannot be rated a good citizen. Astoria business men need your full support today more than they did the morning after the fire.

The writer of this editorial might have added that during the first twenty-one months following the fire, nearly $7,000,000 had been spent for new fireproof buildings. Among the larger structures in the rebuilt area, all of concrete, are the Hotel Astoria, the Elks Temple, the Masonic Temple, the Odd Fellows Temple, the Astor Building, the Astoria National Bank, the Astoria Savings Bank, the Miller-Jeffers Building, the Elliott Hotel, the M. H. Smith Building, and the Astor Court Junior High School. On February 23, 1925, the Astoria Evening Budget published a list of 86 important new buildings constructed since the fire. Astoria now realizes the value of fireproof buildings, for 77 of the structures on this list are concrete and only one is of wood frame construction.

O. A. Kratz, City Manager, Astoria, Oregon

Reconstruction of the Streets

Reference has already been made to the condition of the streets before the fire, the level of which was some ten feet above the natural ground that comprised the tidal flats. The method followed in rebuilding these streets on a hydraulic sand fill between concrete retaining walls was proposed by O. A. Kratz, City Manager of Astoria. In the following article, taken from the August (1924) issue of the *Concrete Highway Magazine*, Mr. Kratz describes the reconstruction.

After the disastrous fire, city officials were confronted with a problem of complete reconstruction of streets in the burned area.

This city of historic interest, was originally built on piling on tide flats. In 1916 the city built a heavy sea wall and raised the street grade sufficiently to allow for basements. A hydraulic fill was then made to the basement level. It was at this time that engineers urged the construction of a reinforced concrete pavement and retaining walls along the curb. It was thought by opponents that this scheme would be too costly. Viaducts of creosoted timber, with plank floors carrying the pavement, were therefore substituted. These streets were burned to the ground.

All of the pavement in the burned area is now reconstructed of concrete on a sand fill.***** Our new fireproof streets and abutments were placed under the direction of R. A. McClanathan, City Engineer. Preliminary plans were furnished by the Aston Step-Wall Co., Portland, Ore.[1]

It is something unusual to speak of fireproof streets, but peculiar conditions give birth to peculiar terms.

The present streets would be in no way affected by fire. Still, we have insured ourselves against a similar catastrophe by building fireproof stores, hotels, banks and other structures as well as fireproof streets. This new construction has enveloped Astoria in a cloak of fireproof material and in its permanence we are to find a new and greater community prosperity.

It was due in no small measure to the vision and determination of Mr. Kratz, who was elected City Manager of Astoria three weeks after the fire, that the city has been so substantially rebuilt. As might be expected, the disaster seemed complete and many of the citizens were utterly discouraged. Few had the vision of reconstruction. But Mr. Kratz and members of the Council formed the nucleus about which the construction organization moved. In spite of the odds they had to work against at first Astoria now prospers and stands as a monument to their efforts and to those of its citizens who now speak of Mr. Kratz as the man who rose to the occasion.

With most of the business portion of the city rebuilt, energies are now being directed to the residential section, a part of which was destroyed by the fire. There existed a scarcity of dwellings even before the conflagration, so that now much needs to be done to provide a sufficient number of them. Particular attention is being given to homes that will resist fire.

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[1] See Concrete, July 1924, p. 28.

Architect's Prophecy Comes True

In a letter dated December 28, 1922, only 20 days after the fire, N. C. Gauntt, a registered architect of Portland, Oregon, wrote the Portland Cement Association (through whose courtesy this article is published) about the destruction of Astoria. He expressed the opinion that concrete bulkheads placed at intervals along the streets and between the buildings probably would have prevented the spread of the flames. It is certain that Mr. Gauntt did not then dream how quickly and how completely his prediction would become a reality, when he said, "It will be a different and concrete Astoria rising upon the ruins."

A. S. T. M. Committees on Cement and Concrete

Meetings of twelve committees of the American Society for Testing Materials, in the Non-Metals Division, were held at the Bellevue Stratford Hotel, Philadelphia, Wednesday, Thursday and Friday, March 25, 26 and 27. They were attended by about 200 members and visitors, comprising engineers and technical experts from the principal cement plants of the country, stone and gravel producers, tar and asphalt companies, public utilities, municipalities, and the Federal Government. The national officers of the Society, president, F. M. Farmer, New York City; vice president, W. H. Fulweiler, Philadelphia, and the secretary-treasurer, C. L. Warwick, Philadelphia, were present and addressed the meetings.

Committee C-1 on Cement, R. S. Greenman, chairman, held a well attended meeting on Wednesday, March 25, at which 40 of its members, coming from all sections of the country, were present out of a total membership of 59. General discussion centered upon the Society's Standard Specifications and Methods of Test for Portland Cement, which have been approved as American Standard Specifications by the American Engineering Standards Committee. The comments of many members and certain reports mentioned below brought out sharply that one of the biggest problems before the committee today is to devise further means for improving the degree of uniformity obtained in test of cement throughout the laboratories of the country. The committee has been at work upon a handbook or manual which elaborates in considerable detail the directions in the specifications for making the several tests called for, that is, fineness, soundness, time of set, and tensile strength. Mr. Ernest Ashton, chemical engineer, Lehigh Portland Cement Co., Allentown, Pa., chairman of the sub-committee in charge of this matter, stated that the manual was practically completed and would be submitted in tentative printed form for consideration of the committee at its next meeting.

Another interesting feature of the meeting was the consideration by the committee of the recently proposed Master Specifications for Cement that have been issued by the Federal Specifications Board. The Master Specifications have not changed the actual requirements of the standard specifications but in many cases have elaborated upon the methods of testing in somewhat the same way that the committee itself has done in the above mentioned hand book.

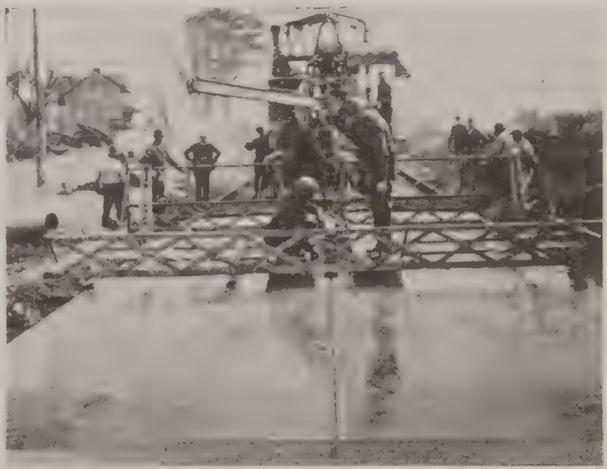
Committee C-9 on Concrete and Concrete Aggregates, Chairman, A. T. Goldbeck, is proposing to revise its Tentative Methods of Securing Specimens of Hardened Concrete from the Structure (C 42-21 T) to include a table of reduction factors for specimens of varying ratios of height to diameter, so as to refer such specimens to the standard specimen having a ratio of height to diameter of 2 to 1. The Tentative Methods of Making Compression Tests of Concrete (C 39-21 T) are being recommended for advancement to standard.

A new sub-committee has been appointed on Design. There are at present a number of theories governing the design of concrete mixtures. It is the work of this new sub-committee to align these various theories. The committee is working on new specifications for aggregate and on specifications for concrete. In order to aid in the securing of data on available deposits of aggregates a form has been prepared on which to record the essential information concerning any deposit. This should serve as a guide in getting specific information.

A sub-committee, which is carrying on a study of various natural or artificially occurring materials in concrete which may affect it deleteriously, will compile as a first step a bibliography on the effect of these various deleterious substances. Such materials include organic impurities, impure water, etc.

Another sub-committee is studying the effect of various admixtures in concrete. It believes that its first efforts should be the preparation of a standard method for determining the weight per cubic foot of the various powdered admixtures, since at present there is no method that has been agreed upon as a standard method. It will carry out a series of cooperative tests in which nine laboratories will determine the weight per cubic foot of powdered talc, oil shale hydrated lime and diotamaceous earth, by the rodding method and direct compression method and compression by means of jigging. The sub-committee will ultimately look into the effect of these powdered admixtures on the strength of the concrete, including in this investigation the effect of similar additions of portland cement.

The durability of concrete under various conditions is a subject of great economic importance. If some concrete will stand up much longer under a definite set of conditions than other concrete, it would be enlightening to know the reasons. It may be that certain precautions can be taken to insure greater durability. One suggestion to accomplish this is a soundness test for aggregate. This is a sodium-sulfate test used to simulate freezing and thawing conditions. Any accelerated test would be very helpful.



Traffic Lines and Road Joints

The illustration shows the Flex-Plane System for mechanical installation of road joints.

The work shown is for the Delaware Highway Department, Stewart & Donohue, contractors, Wilmington.

The producers say that perfectly aligned transverse and longitudinal construction joints are mechanically installed with the machine shown at a considerable saving in time and money, and at the same time building a perfectly straight center joint. The installation of the center joint comprises a collapsible steel plate which is forced into the concrete structure approximately ⅓ to ½ through the slab by a combination of shear and vibratory action produced by the machine. They are left in place temporarily and are expanded by a bar which is inserted within the fold of the plate. After the concrete has taken its initial set, the expanding bar is removed and the division plate collapsed, and withdrawn from the concrete structure and used over and over again. The center joint is then finished by a specially designed tool for the purpose. This produces a weakened or flexible plane through the concrete structure which predetermines the line of fracture.

Various designs of removable center joint plates can be used for producing various widths and depths of grooves in the center of the road, which are later filled with suitable filler to serve for traffic lines as well as center construction joints. A test section of this system was installed in 1923 in Delaware, near Smyrna. Still another section of road was built early in 1924 by the same contractors, this section also being located near Smyrna.

A test section of this system was installed by the Pennsylvania Highway Department near Johnstown, Pa., by the Crissey Construction Co., contractors, Johnstown.

It is said that these joints can be installed with accuracy and precision at a lower cost than by other methods.

Announcement is also made of a machine to install a permanent white cement traffic line, tried out by the North Carolina Department of Highways, on a 3½ mile stretch of road near Wake Forest, Robert G. Lassiter Co., of Raleigh, contractors. This permanent traffic line is 5 in. wide. The machine follows the finishing machine or screed and the final belting operation just as closely as possible. There are suspended within the machine steel cutter blades 12 ft. long, which can be spaced 2, 3, 4 or 5 in. These blades are forced into the concrete structure about ¼ in., and the concrete routed out by specially prepared tools. This routing leaves the channel rough, its depth ranging from ¼ in. to 1 in., the blades, at the same time, preventing the concrete from running into the channel.

While the cutters are still in position a mixture consisting of 1 part white portland cement, 1½ parts white coarse sand, 3 parts gravel or crushed stone of 1-in. to ¾-in. screen is placed between the cutter blades and struck off flush with the road surface, and then, with a specially designed tool which fits neatly between the cutter blades, is drawn along the line, finishing it neatly, with a slightly oval surface.

After the section of the white line has been finished, the cutter blades are raised above the road elevation and suspended in this position, while the machine is moved forward 12 ft. into a new position. The cutter blades are then dropped and the operation repeated.

The cutter blades on this machine are so arranged that they can be curved when necessary for a bend in the road.

The idea of constructing permanent traffic lines in the concrete road is very desirable on the part of highway departments, provided the work can be done neatly and permanently. This machine was designed for the purpose. Further information may be obtained on the permanent traffic line building machine, as well as on the Flex Plane system of construction joint installation, from the Flexible Road Joint Machine Co., 470 Hanna Bldg,. Cleveland, Ohio.

Limestone Planer Dust in Mortars

As a part of the Bureau of Standards research work in limestone, various stone setting mortars are now being investigated, and one of the interesting developments relates to mortar made up with limestone planer dust in place of building sand. The so-called planer dust is the waste product resulting from the machine preparation of limestone when planers, shapers, and milling machines are used. While much of the material is already relatively small sized, the coarse particles are screened out when its use in mortar is intended and the final substance becomes considerably finer than building sand. Mixed with white portland cement in 1:3 proportions by volume, the planer dust mortar has been in satisfactory use for many years in some localities although but little has been known of its properties.

Tests made in this investigation indicate that about 80% of the 28-day strength of a 1:3 white cement planer dust mortar is developed in 24 hours. Compared with building sand mortars, the planer dust combinations have shown from 125 to 200% greater compressive strengths at 28 days according to the conditions of storage. The bonding power appears to be about equal to that of the usual mortar, while the workability is possibly a trifle better. Considering these points it would seem that the use of limestone planer dust in mortar would be quite advantageous in setting limestone, particularly for local contractors engaged in both cutting and setting the stone.

The Economy of Good Roads

The Committee on Economic Theory of Highway Improvement of the Highway Research Board, Chairman T. R. Agg, Iowa State College, reports:

Under year-round operating conditions, average values of rolling plus air resistance appear to be as follows:

BUSSES AND AUTOMOBILES AT 35 M. P. H. HIGH PRESSURE CORD TIRES	
Best paved surfaces	37 lbs. per ton.
Paved surfaces in average condition	42 lbs. per ton.
Best water bound gravel	55 lbs. per ton.
Ordinary gravel	65 lbs. per ton.
Fair to good earth roads	75 lbs. per ton.
Best earth roads	65 lbs. per ton.

For low pressure cord tires, add 10 pounds per ton.

The complete report shows a table of resistance for trucks using pneumatic tires and operating at 15 miles per hour.

Fuel consumption on various road surfaces.—The following tabulation for a Dodge touring car indicates the fuel consumption on various road surfaces:

Types of surface	Miles per Gal.
Gravel in good condition	21.00
Earth in ordinary condition	15.50
P. C. concrete, good	21.42

Vehicle operation cost.—The following table shows the average cost of vehicle operation in cents per mile.

Type of Surface	Type and Speed of Vehicle			
	Solid tire trucks 10 M.P.H.	Pneu. tire trucks 15 M.P.H.	Automobiles 25 to 35 M.P.H.	Motor busses 25 M.P.H.
Ordinary earth with light traffic. Yearly average	9.5	9.95	12.6	29.6
Best earth, well packed by traffic. Yearly average	9.2	9.50	12.0	27.8
Ordinary gravel. Yearly average	9.0	9.40	11.8	27.8
Best gravel. Yearly average	8.5	8.8	10.9	25.7
Best P. C. concrete and asphalt filled brick	7.75	7.70	9.3	22.50

The difference between the effect of certain high type pavements, such as concrete, brick and probably asphalt, upon tire wear is not great, provided these pavements are in high class surface condition. Roughness of surface greatly affects the wear of tires running with standard inflation. Under-inflation probably causes much greater tire wear than is ordinarily attributed to it.

How do you control the quality of your concrete on the job?

Inundation as Aid to Uniform Concrete

Abstracted from a paper by Arthur A. Levison, Chief Engineer, Road Dept' Blaw-Knox Co., Pittsburgh, Pa. Presented at the 21st Annual Convention of the American Concrete Institute, Chicago, 24-27, 1925.

With the inundation method properly adapted to concrete construction, two distinct advantages accrue; first, the constantly uniform measurement of the fine aggregate and secondly, accurately uniform measurement of the water for each batch. Thus two of the most troublesome constructional difficulties are solved with one stroke. Inundation is the most logical and advantageous step of recent years to help in securing that most desired uniform quality of concrete. Uniform concrete means safe, dependable concrete. It means also better service from the structure and greater economy of construction.

By means of the tests which have been developed with regard to the materials commonly employed for making concrete, the proper proportions of water, sand, stone or gravel and cement which are required for the mix can be selected with a great degree of assurance. While the theory of concrete and concrete materials has been subject to diligent study and research, proper attention has not been given to field methods employed on the job. Sufficient consideration has not been given to the practical construction processes commonly employed to the equipment ordinarily used and its limitations and to the field control necessary to make a perfect product.

From data obtained by the U. S. Bureau of Public Roads when every state highway department in the country was circularized in an effort to secure an expression of opinion as to the reason for non-uniformity of concrete, by far the greater number suggested causes for non-uniformity fall under the heading of "Construction Processes." Of the 27 highway departments reporting, 21 pointed to the variable consistency of concrete as a contributing cause of non-uniformity.

Methods and equipment on the job have never been developed to such a point as to adequately counteract the disconcerting variables and conditions encountered on the job. Due to the somewhat haphazard manner in which concrete has been made, a large factor of safety of the structure has been required. As the manufacture of concrete consists of the mixing together of the necessary suitable ingredients in their proper proportions and the subsequent treatment consists of transporting and placing it in the structure and allowing it to harden with protection against rapid drying out and extremes of weather and temperature, no great complexities seem to be involved.

The advanced schemes of measuring aggregate either by measuring boxes or by automatic measuring devices provide more constantly accurate measurements of the material for each batch and permit cleaner aggregates to enter the work than were provided by the methods used not many years back. Yet with these devices and a calibrated tank attached to the mixer or independent of it, delivering a predetermined amount of water to each batch of concrete, there are important variables which are now fully recognized and which have a direct effect on the strength and quality of the concrete. A variable bulking or swelling of sand, due to a fluctuating moisture content upsets the apparently correct volumetric measurements of the fine aggregates although it is possible to make volumetric adjustment for the bulking of the sand, the necessary corrections may involve, making numerous troublesome changes in the volume of fine aggregate and in the measuring equipment.

The measurement of the water for a batch of concrete has a far reaching effect on the quality, strength, workability and economy of the concrete. Even assuming that a constant amount of water is added to each batch of material, the water cement ratio would not necessarily be constant, because of the variable amount of moisture contained in the aggregates, particularly the fine aggregate.

The inundation method which consists of mixing the sand and water for the mix simultaneously and together in the one container or measuring device, accomplishes for the art of making concrete, that which is most desirable as regards the accurate and uniform measure of the fine aggregate and water. It is estimated that when sand is measured in an immersed or inundated condition, the bulking action is automatically destroyed and the volume of the inundated sand is closely comparable to the volume of the same amount of sand in a dry condition. The amount of water required to inundate a constant volume of given sand always remains constant, regardless of whether the original condition of the sand prior to inundation was wet, moist or saturated.

The theory held by many engineers that the volumetric measurement of sand in loose bulk condition is on the side of safety because it results in a richer mortar and therefore a stronger concrete is not supported by the results of tests conducted by the U. S. Bureau of Public Roads in 1294. These test results indicated definitely that for ordinary mixtures the concrete made with the sand measured in a dry condition was equally as strong and in most cases stronger than the concrete made with bulk sand measured loose.

One type of inundator which has been used successfully on the construction of a large number of reinforced concrete buildings in and near New York City, by the White Construction Co., who are the inventors of the process, includes the following equipment: a steel neck attached below the opening in the bin bottom of the sand storage, a lever which operates a shaker gate in the neck, a water supply line and the inundator proper which consists of a cylindrical steel container with an overflow spout near the top and a sand trap separating it from the bottom chamber, which is adjusted by moving the bottom either up or down by means of a hand wheel to adjust the water measurement. In operation, the operator turns the valve and fills the inundator with water to an arbitrary level, about half full. By working the lever back and forth, the sand streams into the inundator from the bin until the container is full, the excess water overflowing from the spout and being carried off by a flume. A latch is then released and the inundator dumps, turning on a pivot and discharging sand and water into the mixer hopper.

The problem of adapting inundation to other than central plant mixed concrete has not as yet been completely solved. For highway work where the paver is on the road, practical difficulties are encountered in connection with the hauling of inundated sand and the water for the mix if the wet materials are deposited in the ordinary mixer skip and the cement is then added, it would involve considerable extra labor to make the skip discharge evenly into the mixer drum. It may be that the inundated sand and water can be hauled out to the mixer in watertight batch boxes substituting a batch hopper for the usual skip loader and using a crane to hoist and dump the batch into the mixer hopper. The other alternative for employing the inundation method in highway work would be to construct pavement from a central mixing plant.

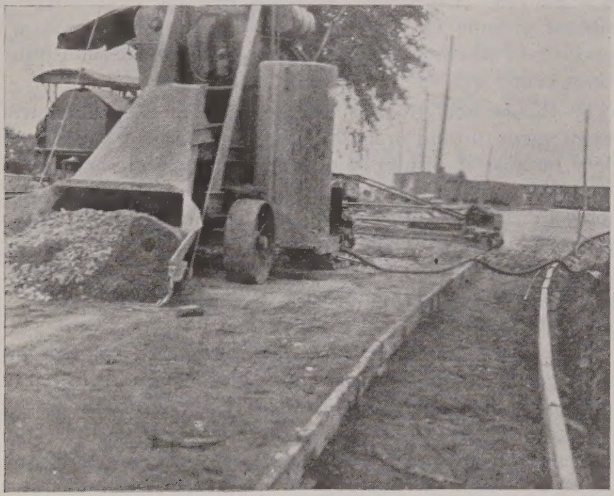
The inundation method of obtaining accurately the correct measurement of sand and water for the mix, together with the devices for accomplishing this are all covered by letter patent.

The Highway Research Board of the Division of Engineering and Industrial Research of the National Research Council has issued not only the complete proceedings of the third and fourth annual meetings of the Highway Research Board, but has also issued a summary bulletin, 54 pages and cover, which treats in the briefest possible fashion, the outstanding features of the reports of the various committees.

Finishing a Widened Curve

Sometimes a contractor wants to know how a mechanical road finisher is used for widened curves. The picture, Fig. 1, supplied by T. W. Dieckmann, The Lakewood Engineering Co., tells the story. A false form is set around the curve for the width of the machine and this width spread, tamped and surfaced by hand. Concrete for this widened portion is of course placed as the machine moves ahead, but the finishing is postponed until after the machine has completed its work.

This false form is generally made of wood, although in some instances light steel channels set legs down on pins or stakes have been employed. This form of course is pulled after the machine has completed its work.



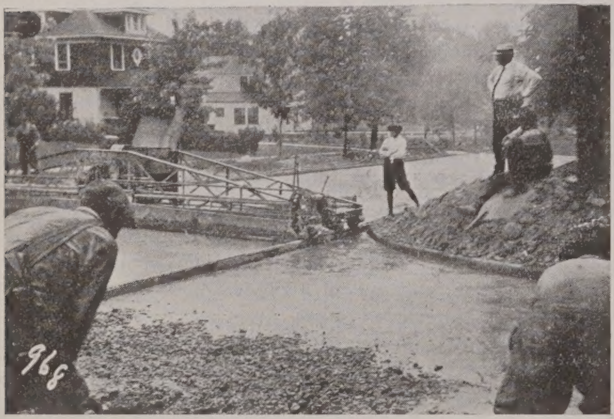


Fig. 1—Finishing machine on a widened curve

Fig. 2—Finishing machine at a street intersection

Fig. 2 shows the Lakewood finisher on city street work. The machine is crossing the intersection. This particular street is 24 ft. wide and the finishing machine was adapted to strike-off and tamp 5 in. below the top of the curb. The wheels travelled directly on the curb. In crossing an intersection, a false form was laid for the width of the machine and equal to the height of the curb. The machine was then operated over this false form, finishing the slab to the proper cross-section and elevation. The corners of the intersection were finished by hand.

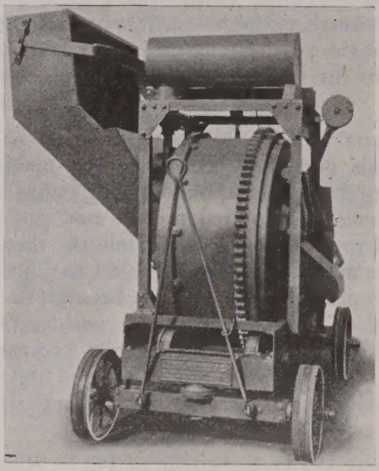
Industrial Buildings of Concrete Masonry is the title of a new pamphlet issued by the Portland Cement Association, consisting of 16 pages, self cover, describing and illustrating the use of concrete masonry units in various types of buildings both industrial and monumental in character.

New Narrow Drum Mixers

The Standard Scale & Supply Corp., Pittsburgh, announces a new narrow drum mixer, the latest development in the industry. The manufacturers claim "speed-time saved" the primary feature. It has a large charging hole, diameter 24 in. and a wide charging chute. When the skip is elevated it attains such an angle that the load fairly drops into the drum and secures rapid charging.

The narrow drum is deep enough to receive the entire charge in one shot, and at the very center of the drum, directly in the buckets where it is mixed. No part of the aggregate is held in the charging chute until the drum revolves.

In the narrow drum just as soon as the material drops in, it begins to be mixed as thoroughly as is possible at any time. The standard engineers assumed that in a narrow drum materials would be pulled together rather than scattered over the bottom of it, necessitating the use of deflector blades to get the aggregate from one side of the drum to the other.



Narrow drum mixer

To avoid the scattering of the load, the walls of the drum were built close together, thus keeping the aggregate within the confines of a narrow space. When the drum is set in motion the buckets lift the aggregate up and with a scouring motion tumble it down. The sand, gravel and cement are all in this narrow space. The aggregate need not be pushed from one side of the drum to the other and the idea is that the mixture is completed in less revolutions of the drum. There is a wide discharge opening (18 in. diameter) and a wide discharge chute.

The Standard mixer is so built that the operator, without moving from his position, manipulates the power-loader lever, the discharge lever, and turns on the water for the mix. With the 24-in. charging hole, he can see into the drum all the while.

Bates Multi-Wall Cement Bags

A new type of paper sack for cement, lime, gypsum and like products has been patented and is now being manufactured and sold by the Bates Valve Bag Co., Chicago, Ill. This new type of bag has 4 walls, each made of 50 lb. paper, providing a container specially composed of 4 sacks, one within the other, with a dead air space between.

A valve is provided in one corner of the sack so that filling can be done with the regular Bates bagging machine. The ends of the bags are sewed through a heavy binding, no paste being required in sealing the ends of the bags.

It is claimed by the manufacturers that this type of bag is a greater protection against moisture than the ordinary bag and is not so likely to be broken open, as one or more of the 4 walls may be punctured and yet the inner walls protect the cement or other material from discharging through the hole. It is also pointed out by the manufacturers that these bags when filled pack readily and permit higher stacking than ordinary bags. It is reported that over 200 cars of cement have been shipped in this type of container without a single bag being broken open.

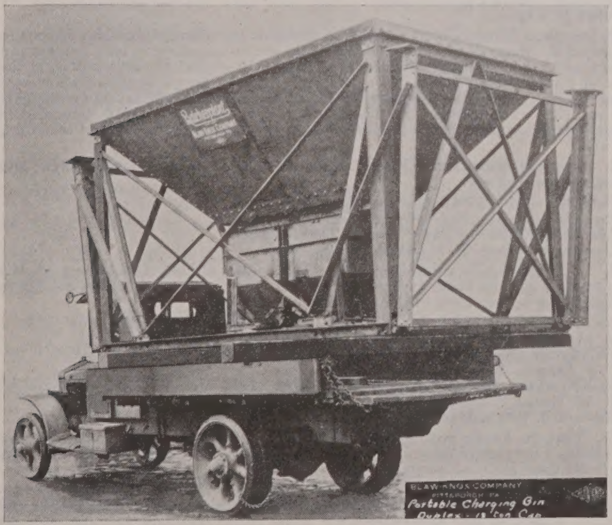
Stake Body for Ford Truck

The Ford Motor Co. has added a stake body to its one ton truck equipment, following the all steel cab and body brought out some time ago. The new body is designed for carrying farm produce, raw materials, manufactured articles and bulky material in general. Stakes, which are easily removable, permit a platform truck of good proportions. Except for floor and rack boards, which are constructed from especially seasoned wood, the body is all steel. The floor space is 5 ft. wide and 8 ft., 2 in. long, sides rise 26 in. above the floor. Racks are in five sections, two on either side and one at the rear.

Ford truck with stake body

Blaw-Knox Batcherplants

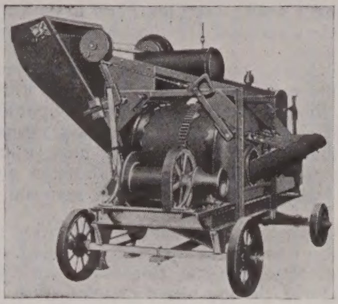
The manufacturers announce that the 1925 design Blaw-Knox Duplex charging bin and Batcherplant incorporates new features of stability, simplicity, ease of erection and portability over those in the 1924 design. The plant is shipped by railroad entirely assembled except for the batchers. Where there is a crane available it is unloaded from the cars and is trucked to the job and erected by simply straightening the legs, which are hinged and folded up during shipment.



The batchers are then attached, 4 braces are bolted in place and the equipment is ready for work, only 8 bolts being used for erection. In the receipt of the plant where no crane is available the Batcherplant can be knocked down before unloading from the car. When the plant is in use and removal is desired to another location, as is often necessary in city paving work, it is a simple matter to drive a truck under the plant, fold up the hinged legs and transport the plant, batchers and all, to its new location. These small Batcherplants are made in 18- and 39-ton sizes, the weight of material being figured as 110 lbs. per cu. ft.

New Model Lansing Mixers

The elimination of vibration impelled the Lansing Company, Lansing, Mich., engineers, to work out the new design for the Lansing 7-S and 14-S mixers. The principle feature to obtain this is to get the machine to hang low to the ground on a rigid and sufficiently heavy frame and axle construction.



New design Lansing mixer

These new models, involve other improvements and refinements, in smooth operation and in mixing action.

The West Virginia Geological Survey, Morgantown, W. Va., has issued a large volume with accompanying maps containing a detailed *Report of Mineral and Grant Counties, West Virginia*, by David B. Reger, assisted by other members of the Survey staff. The book contains 866 plus xxiv pages, 43 halftone plates, and 31 zinc etchings, with a case of topographic and geologic maps. The price of the publication is $3.25.

Trade Publications

Mastertex Waterproof Cement Paint in Colors is the subject matter of an illustrated folder including color samples issued by the Master Builders Co., Cleveland, Ohio, describing this new decorative coating. Mastertex is a fine dry powder which, when mixed with water, forms a paint recommended for decoration and waterproofing of concrete and other masonry surfaces. It can be applied even on wet walls.

Very often the difference between a fire-place that smokes and a fire-place that is a joy forever in the home is a small detail which the builder does not thoroughly understand. To all such, and to everyone in fact interested in the details of fireplace design and finish the Donley book of fireplaces, issued by the Donley Brothers Co., 13900 Miles Avenue, Cleveland, Ohio, will have special appeal. This is the third edition, consists of 24 pages and an attractive cover, 7½ x 10½ in., which illustrates numerous designs for fireplaces from the standpoint of their exterior finish and in detail drawings shows just how they are built, and incidentally how Donley Brothers fireplace hardware is installed and used.

The Besser Sales Co., exclusive distributors for Besser concrete machinery, has issued two supplements describing the company's new automatic stripper type block and tile machines. These supplements are 8½ in. x 11 in. and are illustrated with pictures showing the equipment and the products turned out.

There are a number of interesting features pointed out with regard to this equipment. First, is the use of wooden pallets on which the product is made, the pallet forming the bottom of the mold. The cores which form the air space are a part of the mold construction, instead of being separately withdrawn when the product is to be ejected. Additional mechanical means are used to strip the mold from the product, this being accomplished by bringing in a plunger head, the feet or shoes of which exactly conform to the shape of the webs of the unit.

The supplement describing the automatic face down and stripper building tile machines contains a list of equipment furnished with these machines set up to make the various tile sizes.

New for Old is the title of an interesting publication issued by the Atlas Portland Cement Co., having to do especially with the importance of the use of stucco in rejuvenating, strengthening, and preserving old structures with overcoats of stucco. It is splendidly illustrated with before-and-after pictures. It also tells just how the job should be done to be successful.

Road Building Equipment is the title of a new publication of the Blaw-Knox Co., Pittsburgh, Pa., 28 pages, self cover, letter size, describing the use of Blaw-Knox road forms, Blaw-Knox adjustable measuring batcher, Blaw-Knox batcher plant, buckets, combined concrete curb and gutter forms, turntables and standard steel buildings.

The Subgrader, *Carr Form*, and *Lakewood Finishers* are the titles of three publications issued by the Lakewood Engineering Co., descriptive of equipment used on road work. The *Subgrader* illustrates and describes fine methods of subgrade work; *The Carr Form* is shown in detail in its installation; and *The Lakewood Finishers* includes a consideration of tampers and screeds.

Copperclad is the title of a piece of literature issued by the Flintkote Co., illustrating and describing Anaconda-Flintkote Copperclad shingles. This is a new roofing unit in which both copper and asphalt are employed. The copperclad shingle is described as a pure copper over a base of asphalt. The color plates in the publication give very rich promise as to color value in this new roofing material.

United States Government Master Specifications for Quicklime for Structural Purposes has just been issued by the Bureau of Standards as circular No. 201. Federal Specifications Board Specification No. 250 was officially promulgated by the board on November 5, 1924, for the use of the department and independent establishments of the Government in the purchase of quicklime for structural purposes. The circular includes paragraphs under the following headings: Types; Material and Workmanship; General Requirements; Detail Requirements; Method of Inspection, Tests, etc.; Packing and Marking.

Novo Power, Vol. 7, No. 3, issued by the Novo Engine Co., Lansing, Mich., is devoted to a description of one type of Novo Industrial Hoists which is one of the seven types of Novo hoists, a Novo diaphragm trailer mounted pump and a large capacity contractor's centrifugal pump. In addition a center spread concerns the standardization of Novo engines by the Fred T. Ley & Co. The publication is 8½ in. x 11 in. with 8 pages.

The Novo Company has just issued a loose leaf catalog entitled *Novo Reliable Power*. The various Novo engines are described and illustrated, the other material being accompanied by complete specifications. The descriptive matter includes hoists, direct connected centrifugal pumping outfit and triplex pumps.

The Philip Carey Co., Cincinnati, Ohio, is sending out a very useful pocket scale. The primary purpose is publicity for Elastite. The scale which is printed on very heavy celluloid board gives tables of quantities of materials required to make one cu. yd. of rammed concrete; gives a table in inches, fractions and decimals of one foot; and a table of the total linear feet of Elastite required for transverse expansion joints for 1,000 ft. of road; for various widths of pavement; and distances between joints. The edges are marked off into various scales for easy scaling of drawings.

Alpha Cement—How to Use It is a handbook profusely illustrated, showing the hows and whys of the more nearly every-day uses of cement in concrete construction of various kinds. It will interest almost any handy man who wants to do things of this kind, and at the same time it will acquaint him in a simple statement of fundamentals just how the work should be done to be right.

In cooperation with members of the Chicago Art Institute, the United States Gypsum Co., has made a study of *stucco styles* and textures, appropriate to and artistic for the several architectural styles and motifs. One result of this study which is in connection with the marketing of a ready mixed portland cement stucco—*Oriental stucco*—is the publication of a most attractive and convincing booklet on stucco textures and specifications and presenting a sheet in color of stucco samples in which by means of ingenious dies the actual modeling and texture of the stucco is shown as in a relief map. This booklet should be very helpful to builders generally in steering the public away from abominable botches in stucco in which the resulting textures are absurdly artificial.

Railroad Buckets is the title of a publication issued by the Blaw-Knox Co., Pittsburgh, Pa., 8 pages, self cover, letter size, illustrating and describing the Dreadnaught bucket, single line buckets for handling materials.

Blystone, the Only Mixer that Shovels is the title of a new piece of literature issued by the Blystone Manufacturing Co., Cambridge Springs, Pa., describing the action and the construction of the Blystone mixer which is so extensively used in the concrete products business.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Committee; Dr. P. G. Agne, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High Street, Columbus, Ohio.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., New York City.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION ETC.
REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

Of CONCRETE, published monthly at Detroit, Michigan for April, 1925.

State of Michigan, } ss.
County of Wayne, }

Before me, a Notary Public, in and for the State and County aforesaid, personally appeared R. Marshall, who, having been duly sworn according to law, deposes and says that he is the General Manager of CONCRETE, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc. of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 443, Postal Laws and Regulations, printed on the reverse side of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher—Concrete-Cement Age Pub. Co., Detroit, Mich.
President—R. Marshall, Detroit, Mich.
Managing Editor—Harvey Whipple, Detroit, Mich.
General Manager—R. Marshall, Detroit Mich.

2. That the owners are (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock):

Concrete-Cement Age Pub. Co., 1807 E. Grand Blvd., Detroit, Mich.
R. Marshall, 1807 E. Grand Blvd., Detroit,Mich.
Harvey Whipple, 1807 E. Grand Blvd., Detroit, Mich.
F. F. Lincoln, 441 Lexington Ave. New York City.
R. N. Jackson, 1807 E. Grand Blvd., Detroit, Mich.
R. W. Lesley, Pennsylvania Bldg., Philadelphia, Pa.
Edward B. Bruce, Manila, P. I.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds mortgages or other securities are: (If there are none, so state.) None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also in cases where the stockholders or security holders appear upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner, and this affiant has no reason to believe that any other person, association, or corporation has any interest, direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers, during the six months preceding the date shown above is———. (This information is required from daily publications only.)

R. MARSHALL,
Manager.

Sworn to and subscribed to before me this 30th day of April, 1925.

(Seal.) PERSIS E. HILL.

(My commission expires August 10, 1928.)